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The Basis of Good Railway Location.

Elsewhere in this issue there is an abstract of a part of a report by a committee of the American Railway Engineering and Maintenance of Way Association which has undertaken the important task of formulating the economics of railway location. At the present time there is probably no engineering subject deserving more careful consideration than this, for the data concerning it are mainly quite old and by no means adequate for a thorough analysis of the various problems which arise. It is well known that a large amount of valuable information pertinent to the subject exists in the engineering departments of a number of railroads, but for one reason or another has never been made public. From time to time a paper on some feature of railway location is presented before a technical or railroad society, which always brings out a valuable discussion, but such contributions are confined to a few topics only, and by no means give a comprehensive view of the whole matter. Fortunately for the engineering profession the committee of the Association which has been intrusted with this investigation contains representatives of many important lines and numbers among its members engineers whose reputation as specialists in railway location is of the highest character. Its findings may therefore be expected to be both conservative and authoritative. The subject is a particularly important one at the present time because of the relocation of old lines which is becoming necessary everywhere, and the extension of the facilities of lines fairly well located at one time, but presenting quite troublesome problems in caring for the present volume of traffic. A very nice balancing of the advantages of more tracks on existing locations or of new locations has to be made at frequent intervals, and many engineers make no bones of acknowledging that a good deal of their work of this nature is purely empirical, owing to the fact that the many demands on their time make any elaborate investigation impossible. For this reason the investigations of the committee seem likely to have a value to railway engineers which can hardly be over-estimated.

Those who have had an opportunity of becoming acquainted with the German literature on the economics of railway location have been impressed with the great value of some of the general principles and theories it contains. Unfortunately it is not directly applicable to American conditions. One reason is that train resistance is a very important factor in determining the best location under many conditions and as train resistance in this country is very different from that where German rolling stock is used, the elaborate monographs of the subject printed abroad are mainly useful as guides rather than direct helps. In this country nothing distinctly new has been written since the late A. M. Wellington produced his well-known book. The data in that book, and consequently the conclusions based on them, are now so out of date that the volume is not a practical help. It was a great assistance when it was brought out, but at the present time it is mainly of historical value. In fact it may be questioned whether any book can possibly be written which will be much more valuable until the large amount of definite information on which the theory of location must rest is dug out of the archives of the various railroads. Fortunately the committee of the Association has undertaken this work of gathering and sifting the great amount of valuable data which can be obtained from such sources, and a portion of it has already been published in its first report.

The work of the committee will also have an important bearing, it is to be hoped, on the discussion of railroad affairs which is taking place at the present time. Nobody can read the preliminary portion of its recent report, published elsewhere in abstract in this journal, without learning some of the valid reasons for the so-called over-capitalization of railroad lines. The clear and definite manner in which the committee explains the reason that many railroad lines are justifiably capitalized at more than the cost of their present roadbeds deserves careful study. This statement is not prepared for political-economic purposes, but is the sober judgment of an engineering committee representing men who have made a life-long study of railroad location. If a good many railroads had not proceeded step by step to spend money for lines of gradually improved location and grades, all costing considerable money, methods of communication would be far inferior to what they are at the present time. Few companies have ever been in the position to build roads on the best lines originally. They have had to build lines which were possible with their available capital. The economic theory of railway location is concerned directly with this problem of building the best line which the country and its probable development within a reasonable time warrants. While the technical intricacies of the various facts upon which this theory is based are probably too much complicated by engineering details to be comprehensible by the public, nevertheless their main facts are readily grasped, and for this reason it is believed that the article elsewhere in this issue will prove very illuminating to many who wish to understand the railroad problem.

Concealed Piping in Power Plants.

The arrangement of the piping in a power plant is often one of the most difficult features of the entire design. While the high-pressure lines may be disposed of in a fairly simple scheme, the exhaust and auxiliary piping generally has to be placed with great judgment on account of space limitations. It is an important question whether the piping in general shall be of the concealed or exposed type. The basement naturally suggests itself as the best place for auxiliary piping, because the condensers, pumps and principal exhaust lines are rarely placed in the engine room proper. The main points for consideration are the wisdom of locating live steam lines in the basement and the desirability of floor openings which will render the auxiliary and exhaust piping more accessible for inspection and repairs.

If the high-pressure steam lines are located in the basement, supplying engine cylinders and turbines through short risers carried but a few feet above the floor, the clearance space for the operation of the crane in the engine room will be greatly increased, the appearance of the room improved, and the cost of installation but slightly augmented. But it is doubtful if the mere question of crane movement is of sufficient importance to bar live steam piping from the engine room in the great majority of plants. It is more desirable that the lines between the boilers and the engines, including the main headers, be as short as consistent with proper provision for expansion and contraction, than that the engine room shall be absolutely free from all overhead equipment. Except in plants of many thousands of kilowatts capacity, the crane stands idle for weeks at a time. It is essential that all live steam pipes shall be immediately accessible in times of trouble, and if these are located in the basement closely or interlaced with exhaust and auxiliary lines, facility for repairs and replacement of defective sections is liable to be seriously obstructed. Complication is undesirable in the pipe layout no less than in the wiring system. When the boiler room floor must be at a very much lower grade than the engine room, it may be the better plan to install the live steam lines in the basement, but a careful weighing of both sides is always essential to a practical design.

The removal of the main steam pipes feeding the engines from the basement enables the exhaust and auxiliary lines to be disposed of to better advantage, and permits a better placing of high pressure pump connections for oversight and repairs. The cost of repairing a complex layout of heavy pipes is greater than is generally realized by designers. Hence the railed floor opening near each unit, even though it be not over 10 ft. square, becomes a valuable aid when quick replacements have to be effected. Broken parts of pumps, valves and other heavy supplies can be handled with despatch through even a small floor opening by the overhead crane, and in frequent cases the latter can be pressed into service, instead of special heavy tackle or timbering, to hold parts of the piping in suspension while repairs are made in other sections. There is not much doubt that exposed piping tends to favor the continuity of service, and the floor opening removes the conditions of isolation which are at times such a decided disadvantage in the basement. Such openings need not be left uncovered if the conditions in the plant demand a continuous floor. Accessibility is hard to secure in installations where every inch of space must be taken into account, but it is worth striving for in all plants subject to the aches and pains of a disordered steam circulation.

The Collapse of a Filter Roof.

There will be found on page 524 of this issue an account of the recent collapse of the groined concrete roof arches of the Lawrence filter, which deserves more than a passing notice. These arches, like many used for the same general purpose, are of short span and were intended to carry an earth covering 3 ft. thick after completion. The specifications and the design appear to be satisfactory, yet a large part of the structure, after standing through the winter on the supporting centers, collapsed when the latter were removed. In the account of the accident it is stated that the difficulty is supposed to be the action of frost on the concrete, but there seem to be other important considerations connected with such an assumption.

The clear span of the arches between the columns is 13 ft. 2 in., and the depth of the concrete at the crown 6 in., the rise of the arch at the center of the span being 2 ft. 9 in. The thickness of the arch at the crown is therefore a little more than one-thirtieth of the span. The elliptic curve of the arch produces a flat portion of thin groined shell at the center of each square, which obviously should be of the best quality of material. The specifications required the concrete to be a mixture of one volume of cement, three of sand and five of clean gravel or broken stone, gravel having been used. It would seem that such specifications properly enforced would secure a structure which ought not to fail, either with or without the action of frost in the new concrete, although a mixture equivalent to one cement, two sand and four broken stone would probably be preferred by some engineers for work of this character, especially with so small a thickness at the crown.

There are some details of the work which are not given in the account of the failure to which much interest would attach under the existing conditions. Presumably even so small an arch would be designed for such work by constructing the line of resistance for the actual loads which the shell might carry both during construction and after completion. The position of such a line of resistance in an all-concrete arch of these dimensions would have a most important bearing upon the failure of the work. The loading would give to the line of resistance very closely the form of Rankin's geostatic arch for the full thickness of earth covering. On the other hand if the earth covering were placed carelessly so as to produce a greatly unsymmetrical loading during construction it might not be necessary to refer to the existence of frost to account for the final results.

There is much in connection with these details of the matter which ought to be set forth thoroughly in a search for the causes of such a failure. The shortness of the span and the comparative frequency with which such groined arches have been successfully completed might easily lead to either carelessness even in design or indifference to the manner of loading while placing the earth covering. A 6-in. depth of arch ring, especially in a groined arch, even of no longer span than this one, does not imply any substantial surplus of material. While with proper treatment there might be enough of concrete, it should be of the best quality and every exigency during construction should be scrupulously provided for. It should also be observed in this connection that some portions of the crowns of the groins come very near to taking the character of beams rather than of arches, in which a little steel reinforcement would not be out of place.

Much stress appears to be laid upon the fact that the new concrete was subjected to the freezing weather of the winter although apparently well covered or protected. It is even stated that some of it at least, and perhaps much of it, was found to be soft or crumbling without the hardness and strength which should characterize Portland cement concrete of such a mixture. This in itself is not necessarily conclusive as to the action of frost. The experience of laying Portland cement in freezing winter weather under suitable conditions is no longer experimental or rare; it has become a common practice. It is true that in such work the placing of the concrete is suspended during the severest days of the winter, but on the whole the placing of Portland cement concrete in building construction is no longer necessarily seriously interrupted by the winter weather of this climate. Further than this experiments have shown that even alternate freezing and thawing of new concrete will not necessarily injure it seriously if it is reasonably protected while taking the initial set, as appears to have been done at Lawrence. Under such circumstances the freezing conditions following the placing of the concrete, which were maintained fairly continuously through the winter while the work was suspended, seem scarcely sufficient to account wholly for the failure, although it is barely possible that they may do so. The question that arises in the mind of an engineer experienced in such work is whether the softness of the material disclosed at the time of the collapse was due to the action of frost or to a failure to thoroughly incorporate the cement in the mixture. There are probably few engineers who have done much concrete work who have not seen spots of scarcity of cement with apparently the results indicated in the descriptive account of this accident, and which are cured by a thorough mixture of all the ingredients. At any rate, in view of the admirable results which have been reached in making and placing concrete in severe weather it would appear to be necessary to adduce additional evidence before frost can be considered conclusively the cause of the failure.

There is another feature of the work, entirely independent of the character of the material, which needs attention, and that is the failure to oblige the contractor to complete his work within the time specified in the contract. The interests of the municipality seem to be well guarded by the terms of the contract, which were certainly drawn with commendable care in this particular, and yet the work was allowed to drag along far beyond the contract time. If the contractor had lived up to the terms of the agreement the work would have been completed before the winter set in and all questions arising from the action of the frost would have been eliminated. Inasmuch as the public health in a large city was dependent in no small degree upon the prompt completion of the work, the contractor should have been obliged to perform his part promptly and efficiently.

Reducing Depreciation in Gas Engine Plants

The operating problems of gas-engine plants differ so broadly from those of the average steam-driven installation that unless the force in charge of the equipment constantly makes allowance for the changed conditions, maintenance charges are sure to become excessive and depreciation abnormal through extreme wear and tear. Close-range observation of the conditions in the gas plant tends to create an entirely new point of view in the minds of thoughtful steam engineers entrusted with the operation of internal-combustion engines, and as it is largely from this class of men that the gas engine attendance must be recruited, it is most important that every operating company shall encourage in all feasible ways the efforts of its engineers and firemen to become acquainted with gas-engine practice. Fewer men are probably required to operate a gas engine plant of given capacity than are needed to run a steam station of the same size; in a recently visited producer gas plant of 700-kw. rating the force was but one-third that necessary in a steam plant of the same capacity; but there is no question that the work per man tends to be much more exacting. The economy of this plant, 1.3 lb. of coal per horse-power-hour, is only secured by the most intelligent control and supervision of its equipment. The fact that the working force is smaller, with a larger responsibility per employee, justifies the company in making certain that the operating shifts know what they are about, in the most exact sense of the words.

To this end a complete cross-sectional diagram of the installation is framed in the engine-room, with the various apparatus illustrated in colors, so that the exact course of operations between the charging hopper of the producer through the various scrubbers, tar extractors, and holders to the engine cylinders can be readily followed. The cycle is not as direct as in a steam plant; the equipment is relatively new to the company's practice, and the need of accurate diagrams is much greater than in the simple case of live or superheated steam supply to an ordinary engine or turbine through the usual risers, header and main. Careful work is also encouraged by the framing and posting of complete operating rules, one set applying to the engines and another to the producers. It is scarcely to be expected that the work in such a plant can attain the standards of smooth operation common in the better class of steam plants until experience has shown the men how to treat incipient troubles symptomatically, although there is no question about the reliability of the installation. In the gas plant it is more a question of securing those refinements of operation which keep the repairs at a minimum through the prompt forestalling of small troubles.

The fundamental needs of a low-depreciation policy are mainly the supply of the proper quality of gas with the best mixture of air, the control of lubrication within very close limits, the maintenance of good ignition, the continuous supply of clean cooling water and regular observation of its temperature as discharged from the jackets, and the enforcement of a maximum degree of cleanliness in the whole installation. Some of these points are common to steam engine practice, and of course the same general questions of forestalling leaks in the piping apply with force to both kinds of service. In the gas plant, however, everything centres in the compression and explosion actions in the engine cylinder. Premature ignition is almost certain to cause undue strains in the cylinder itself, and in some cases will stop the engine in spite of the inertia of a heavy flywheel. The adjustment of the ignition point is thus a most important matter, and in this connection arises the necessity of special care to prevent the entrance of too much oil into the cylinder, with all its possibilities of carbonization, overheating and pre-ignition of the charge. One drop per minute for each inch of cylinder diameter is a suggested desirable practice in this respect, especially in installations where the cranks receive some lubrication by splashing. Wrist pins in a medium-size engine may require 15 drops per minute, but only a very small quantity of oil is essential in other places, such as valves and levers. Of course these figures may vary somewhat with different types of engine, but they emphasize the importance of a careful control of the oil.

The dangers of overheating in the cylinder are by no means fanciful, with the high temperatures occurring during explosions. A sudden variation in the temperature of the discharged circulating water may result from causes which will stick the piston and possibly create serious damage. The evil effects of tar are too well known to need emphasis in these comments. As it is impossible to see what takes place in the cylinders, the sound of operation must be the principal guide in skilled attendance, and the importance of rapidly acquiring a trained ear cannot be overestimated. The stopping of engines at the proper points for starting is an essential feature of good practice, and the frequent inspection of the ignition apparatus may well be supplemented by the use of small electric indicators included in the sparking circuit which will show that the discharge is proceeding with the proper regularity.

These points all bear upon the question of uninterrupted service, and if their practice is enforced, there is no reason why the operation of a gas plant should appear in the least formidable to a trained steam engineer. Experience counts heavily in all work of this kind, especially where comparatively new types of equipment are involved. Low maintenance charges and decreased depreciation cannot be had without intelligent care of the machinery in any station, but in the gas plant in particular there is no place for ignorant experiments. The main issue is for engineers to get the right point of view in looking at the engine cycle and to encourage intelligent work on the part of the operating shifts.

Maintenance and Depreciation in Mills.

At the convention of the National Association of Cotton Manufacturers in Boston this week, Mr. H. S. Chase read a paper on the cost of maintenance and depreciation of mills which brings up a subject that has often caused engineers engaged on appraisal work a great deal of study. It is easy enough to assume a general rate of depreciation on buildings and equipment of certain sorts, but it is a different matter to determine definitely just what such items should be in a given case. There are few features of appraisal work which call for a more thorough knowledge of mill architecture than the estimation of the probable life of buildings and equipment. This life is affected not only by the original design and construction, but also by the character of the maintenance, and only ripe experience will enable one to estimate with accuracy what is a fair present valuation. It is natural to expect some help from the books of the company whose plant is being appraised, but unfortunately it is customary to hide such figures in order to reduce taxation, a practice that Mr. Chase condemns vigorously. As this bookkeeping juggling has very rarely been criticised openly before, it is worth while in this case to quote what Mr. Chase says: "We acknowledge that a mill may and frequently does avoid taxation to a considerable degree by cutting down the book values of its assets and by concealing the true amount of its invested capital. . . . All mill experience, failures and successes alike, goes to show that there must be ample reserve. The only question is this, shall reserves be secret, or shall they be openly entered as actual accounts in the books? What would an impartial outside observer advise? Would he not urge that careful estimates be made periodically, covering these doubtful elements and unknown contingencies and that such amounts be charged to expense pro rata over the whole of the period and at the same time credit it to one or more depreciation reserves, which will stand upon the books as liability accounts. Thereafter all actual expenditures for reconstruction and renewals, other than current repairs, will be charged against reserve account, whose balances at the end of the period will be carried forward to the new period."

Engineers who have had occasion to be connected with many industrial establishments recognize that these comments if carried out would furnish information decidedly valuable not only to them in their work, but also to directors of plants. It often happens that accounts are presented to directors, to aid them in reaching a decision as to future appropriations, which are quite misleading. They do not show the company to be more prosperous than it is, but have exactly the opposite effect. Few directors are closely enough in touch with the affairs of such corporations to appreciate that their undertakings are really better off than the figures show, and in consequence a feeling of ultra conservatism arises which puts them to a disadvantage in laying down future policies. Before competition became so strong in all lines of business and manufacturing, there was considerable excuse for the manager who placed before his board of directors a statement in which everything was estimated on the safe side. When his reports showed less than the real value of the buildings and equipments, when his materials and stock on hand were appraised below their actual market value and his estimates of future business were under rather than above the probable amount, nobody was being very much injured, and the manager was leaving for himself a considerable leeway in which to exercise his individual judgment. At the present time such a course is not right. The history of public service corporations has demonstrated beyond any question that the exact facts as to values and operating and fixed charges are essential, or directors will do serious harm to their properties by adopting a programme which the real standing of the corporations renders ultra-conservative and timid. It is very difficult to hide real facts as to operating charges and such items, but the opportunity for doing so in everything relating to the depreciation, maintenance and obsolescence of the property are very great. In fact it is sometimes possible to notice in reports of large industrial corporations that a comparatively small change in the figures for these items would make a difference between a profitable and unprofitable year.

Attention is called to the matter here because publicity in such subjects must probably come through the united efforts of engineers. At the present time the only general figures relating to the depreciation of building which have regular commercial use are those prepared by the engineers of insurance interests. These figures are admittedly only rough approximations, but in the absence of anything better they must be accepted for the present as fair to all concerned. That they are not correct, except in a very general sense, is evident to anyone who has appraised plants of the same sort for various companies which propose to consolidate their interests. Engineers who have been engaged in such work always observe that plants of nominally the same character and making the same line of products actually have a considerably different value, for one reason or another, although the accounts of the various companies rarely enable that value to be estimated and the appraisal must be made on the basis of the engineer's general judgment of what he can observe of the condition of the buildings and equipment. The subject is a very complicated one, at the best, but there is no reason for doubting that Mr. Chase is entirely justified in saying that a correct estimation of it will shortly become a matter of life or death to many manufacturing companies.

The Cement Laboratory of the Reclamation Service at Denver has been removed to Chicago to quarters provided through the courtesy of the Armour Institute of Technology. The work done in the laboratory is mainly testing cement purchased for use on the various projects which the Service has under charge, except those on the Pacific Coast, the supply for which is tested at the laboratory of the Engineer of Soils at Berkeley. The cement of the Salt River project in Arizona, which is made by the Service, is tested at its mill. In addition to these tests, the laboratory also carries on some experimental work, such as tests of sand-cement, and tests of sand and stone for concrete materials. It is also equipped with an outfit to test the permeability of cement mortar under water pressure. One feature of its work which will be of decided interest is long time testing, arrangements being made for ten-year tests of many different brands.

The Dyke Type of Earth Dam, first introduced on an extensive scale at the Wachusett reservoir, at Clinton, Mass., is in no way discredited by the recent sliding of a portion of the face of one of the dykes of that basin. As explained in some detail elsewhere in this issue, the portion of the structure which slid a fortnight ago was made of rather poor sandy material removed from a cut-off trench and placed on the two toes of the dyke as secondary embankments to face the impervious material which was relied upon to make the work water-tight. It is generally understood that this use of sandy material at the toes was not originally contemplated when the plans for these structures were outlined by the former chief engineer of the water works, Mr. R. P. Stearns, but were adopted later at the suggestion of the consulting engineers of the Metropolitan Water Board. Nobody would rely on the material which was in them for a reservoir embankment, and apparently the reason it was used at Clinton was because it had to be placed somewhere, and this position for it was as good as any. The fact that it has slid cannot be wholly explained, in the light of present knowledge, by its fine sandy character, for it rested on a rather bad stratum of soil, which may itself have been the cause of the slip, and carried a very heavy load of rip-rap on a berme some distance above the water line in the reservoir at the time the slide occurred. Either or both of these factors may just as likely have been the cause of the slide as the character of the material used in the embankment. All that the incident shows is that where material of a pervious sandy nature is used for facing a reservoir embankment it must be placed on a slope considerably flatter than that which it naturally assumes when dumped from a height. The slip of this embankment is no more a proof of the lack of merit of the dyke type of construction than the slips of linings of reservoirs of the usual construction are demonstrations that that type of embankment is unreliable.

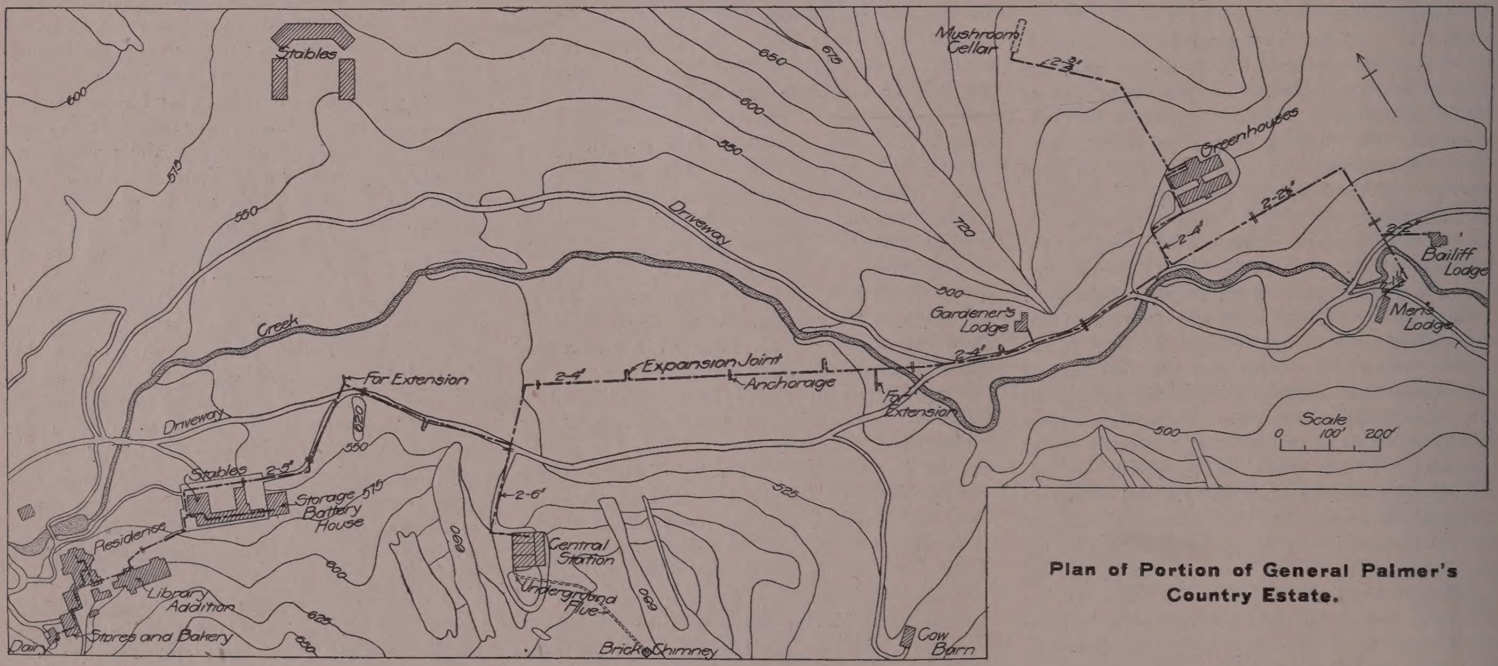
THE CENTRAL STATION FOR HEATING, LIGHT AND POWER AT GLEN EYRIE.

Description of the Plant on the Country Estate of General Wm. J. Palmer, near Colorado Springs, Colo.

By Konrad Meier, Consulting Engineer, New York.

The Situation.—To locate a central station for heat, light and power amid the exquisite scenery of Glen Eyrie seems at first like an intrusion into one of nature's gardens. The owner, however, has always treasured its beauty, which is enhanced, and really due, in part, to the peculiar freshness and purity of the surroundings. It was, in fact, the idea of preserving these that led to the concentration of the numerous sources of smoke that had become objectionable, as the best means to reduce and to avoid them. The desire for this will be appreciated by all who have enjoyed the extraordinary clearness of the atmosphere characteristic of Colorado, which unquestionably renders pollution more noticeable than elsewhere, and more annoying.

The estate is situated at some distance from the nearest city, and the supply of heat, at any rate, could not have been procured through public town service. A private central station to serve all the buildings scattered over the grounds seemed, therefore, the only alternative. Through the opportunity of utilizing a cheap fuel mined nearby, in place of anthracite and oil formerly bought at high prices, centralization became a sound proposition economically, even for an output necessarily limited. It tended, also, to make the estate more independent of outside supplies and self-contained as a settlement.



Plan of Portion of General Palmer's Country Estate.

The concentration of all fires into a single furnace offers the opportunity to burn the fuel under better conditions, giving the best guarantee for preventing smoke altogether. The plant thereby might furnish an incentive to other owners, by showing what can and ought to be done to prevent pollution of the atmosphere in a part of the country where its purity is of peculiar vital importance. The rapid settling of Colorado and its industrial development now bid fair to obscure its sunny skies and infest the health-giving air. There is no excuse for industries to interfere with sanitation. Indeed, development on the right lines, merely on true scientific lines, of efficiency or economy, will show that all drawbacks to health, especially in the form of smoke, fumes and dust, affecting the community as a whole, can be avoided, and with benefit to all concerned.

The buildings served from the central station are scattered over a considerable area, at different levels. They include several lodges, greenhouses, stable buildings and a main residence with extensions for entertaining and for service. The power house, naturally, was placed as near the center of the group as feasible. It was desired to make it not only inconspicuous in bulk, but unobtrusive as well, by the absence of smoke, vapors and other undesirable features, too often accepted as necessary evils.

The site plan shows the buildings, the furthest point reached being close to 2,600 ft., and the principal group, including the residence, about 1,500 ft. from the station.

As a preliminary to the solution of the problem the various requirements for heat at the different points of use were established. The power needs for light and other service were determined by the electrical engineer. The prospective tax on the central plant was then charted for a 24-hour run, under average conditions obtaining in winter and summer, also for the tax in coldest weather. It was found that the heat for warming the buildings and for the hot-water service, etc., would be greater than the thermal needs of the electric generating plant, at nearly all times of the day during the winter season, and for the greater part of the time even during the summer. The storage capacity of the electrical equipment tended further to bring the power load within that for heating. If operated by steam, the plant appeared to permit almost complete utilization of the exhaust for the heat service, and to obviate thereby the expense for certain refinements in power equipment which will pay only when assuring substantial fuel economy. Since boilers were necessary in any event, for heating, steam power clearly offered in this case a solution which could hardly be approached by a producer gas plant or other combination, quite aside from the advantage of using the cheap fuel available.

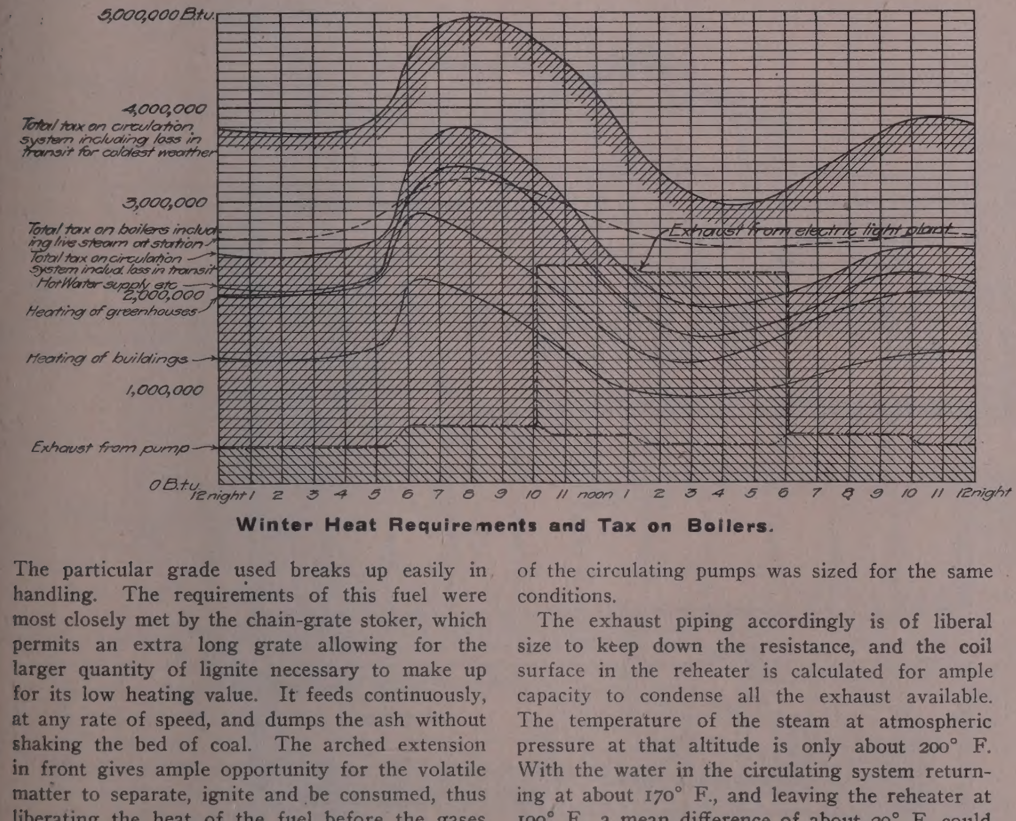
The decision for a steam plant at the central station still left open the question as to the carrier of heat between the buildings. The exhaust from engines and pumps, in combination with live steam at reduced pressure, might have been reasonably economical in operation, but on account of the long distances to be traversed, the mains figured too large, even under vacuum applied at the far end, to be a good investment. The cost would have been increased further by complications in overcoming the grades. The same difficulties would have been met in using live steam, unless superheated to eliminate condensation along the line. This was not thought to be desirable in view to first cost as well as maintenance, inasmuch as any economy in steam to the generators would be more than offset by wasting part of the exhaust, or by extra expense in installing, and difficulties in keeping up a small plant with superheating and condensing features.

Forced circulation of water promised the best solution, first, by reason of economy, the pipe sizes figuring reasonably small; second, on account of the reduced heat losses, both in quantity and in potential, owing to the comparatively low temperature of the medium and moderate surface of exposure; third, from the ease with which grades are overcome.

A return system is, of course, essential to economical operation by hot water. Duplication of the pipe lines, however, by no means duplicates the cost of the conduits, since excavation and other items are not increased in proportion. The avoidance of reducing valves and traps or pumps at the far end of the line, and the use of cheaper insulation, bring the cost probably within the estimates for a one-pipe high-pressure steam line. The advantage as to thermal economy in favor of hot water seemed to justify the expense of circulating pumps and the reheater, which would surely not exceed the outlay for a condensing plant, even though it had been feasible on account of the scarcity of water.

The Boiler Plant.—The smokeless combustion of the cheap fuel available at the premises was accomplished, not by any particular smoke-consuming device, but simply by the use of standard commercial apparatus selected for its fitness in meeting the conditions and proportioned for the requirements.

The coal used, as mentioned before, is mined in the neighborhood, within carting distance. A certain amount of storage capacity was desired for several reasons, and bunkers were provided for a supply to last, under good management, for the best part of a winter season. Owing to the restricted height of the power house, storage above the boilers and feeding by gravity could not be arranged, and the bunkers had to be located in front, the fuel being dumped into them from a driveway leading to the top. Above a certain level the fuel can be drained directly into a charging car running on a track to convenient position for firing. The fuel below that level is considered as reserve, to be drawn out and renewed only as far as necessary to prevent decay and spontaneous combustion. Rising temperature in the bunker can be detected by means of special thermometer tubes. To reduce dead spaces where coal would lay indefinitely and threaten to rot, the bunker bottom was designed with valleys leading to the lower outlets. It is also ventilated by windows on either end and water is drained off at low points.



Winter Heat Requirements and Tax on Boilers.

The fuel is a lignite averaging about 40 per cent. fixed and 35 per cent. volatile carbon, 20 per cent moisture and 5 per cent. ash. Its heating value is not over 8,000 B. t. u., giving at best an evaporation of 5.5 times its weight. It burns with a fairly bright, long flame, which will turn into smoke when chilled by contact with cooler surfaces, or with cold air entering the furnace, being similar in this respect to bituminous coal, though these qualities are not as pronounced. The particular grade used breaks up easily in handling. The requirements of this fuel were most closely met by the chain-grate stoker, which permits an extra long grate allowing for the larger quantity of lignite necessary to make up for its low heating value. It feeds continuously, at any rate of speed, and dumps the ash without shaking the bed of coal. The arched extension in front gives ample opportunity for the volatile matter to separate, ignite and be consumed, thus liberating the heat of the fuel before the gases become chilled in transmitting it to the boiler tubes. The air for combustion is effectively warmed in passing through the returning portion of the grate. An extra supply of heated air is secured through by-passes built into the brick walls on either side of the furnace. Aside from the loss of a certain amount of slack falling through the grate, which can hardly be avoided with the quality at hand, on any grate, this lignite is now used to best advantage. It is burnt absolutely without visible smoke, even under full load, and with a very moderate excess of air, as shown by the flue gas recorder, which indicates on the average 12 to 14 per cent. of CO_2.

The mechanical draught arrangement which will be noticed on the plan of the boiler house is not installed for better utilization of the gases, as the heating surfaces and smoke passes are ample in any event to give high efficiency. The flue temperature, in fact, averages less than 350° F. Neither was it justified to secure better control over the air supply to the furnace. It became necessary because a tall smoke stack, which would have to be of the height of the surrounding cliffs, was objected to in the location given for the central plant. The chimney accordingly was placed on more open ground, and reached by an underground flue about 350 ft. in length. Although run on an upward grade, and with a total height which would be ample for a short connection, the ratio of height to length of the flue as a whole did not assure sufficient draught for all conditions. This is due in part to the cooling of the gases in the underground flue which makes it impossible to raise steam, under load, without mechanical provision for draught.

Heating Arrangements at the Central Station.—The steam plant in other respects presents no features of special interest, except the method applying the exhaust steam and of handling the condensation, as brought about by the use of steam turbines.

The units for the electric generating plant were selected to develop the required power without resort to superheated steam and vacuum. It was most desirable, however, to avoid back-pressure, which would decrease their efficiency beyond a point that could conveniently be made up by using the exhaust. The steam turbine for driving one of the circulating pumps was sized for the same conditions.

The exhaust piping accordingly is of liberal size to keep down the resistance, and the coil surface in the reheater is calculated for ample capacity to condense all the exhaust available. The temperature of the steam at atmospheric pressure at that altitude is only about 200° F. With the water in the circulating system returning at about 170° F., and leaving the reheater at 190° F., a mean difference of about 20° F. could be depended upon between the exhaust steam and the water. The rate of heat transmission for similar conditions is variously stated to be anywhere from 500 to 1,000 B.t.u. per square foot per hour, for 1° F. difference, through brass coils, the coefficient probably depending much on the movement of the fluids. Under forced circulation it was assumed that 600 B. t. u. would be a conservative estimate. For 20° difference the rate of transmission thus figures 12,000 B.t.u. per square foot per hour. The diagram of loads gives the amount of heat furnished by the exhaust under ordinary conditions to be 2,300,000 B.t.u. per hour. This would require a coil surface of about 200 sq. ft. The actual amount provided is 300 sq. ft., allowing for additional exhaust or for higher temperature of the circulating water.

The heating surface for live steam, used whenever the exhaust is not sufficient, consists of separate coils. The chance of back-pressure on the turbines is thereby reduced to whatever might be caused simply through resistance, owing to the failure to condense. An automatic regulator is provided which admits live steam only at a desired water temperature, to prevent such occurrence. Any vapor that might escape from these coils will pass thence to the open feed water heater, together with the exhaust from the feed pumps and is likely to be condensed by contact with the fresh feed water.

The use of steam turbines for the bulk of the power generated eliminated practically the grease problem, inasmuch as the exhausting under atmospheric pressure excluded also any oil from bearings that might be drawn into the steam passages under vacuum. The entire condensation is therefore clean, with the exception of the small amount from the stoker engine and feed pump. The latter is taken care of by the separator, filter and oil skimming arrangement of the combination feed water heater and receiver, which are very ample for that duty. Provision is also made for exhausting direct to the atmosphere, from the pump line as well as from the turbines, so that the receiver and filter can be shut off at any time and kept in efficient condition.

The feeding to the boilers is done in the usual way, the fresh water being fed to the receiver by an automatic float valve, replacing the small amount that is necessarily wasted through blow-off and drips. The blow-off tank is drained into a cesspool, built into sandy soil, and is noticeable only through the stimulated growth of vegetation over it. Under ordinary conditions no vapor is seen around the power house.

Schedule of Heat Appliances.

	Heat required, B.t.u., per hr.	Temperature required.	Surface in coil heaters. sq. ft.	Water required, Gal. per. min.	Circulating connections, ins.
Residence—					
Direct heating....	385,000				
Indirect stacks...	202,000				
Tempering coils..	198,000				
Air moistening..	90,000				
Mains and risers.	50,000				
	925,000	100° to 180°	155	92.5	3½
Hot water supply.	292,000	165°	48.8	29.2	2
Plate warmer, dir't	5,000	180°	—	.5	½
Hot water urn....	25,000	180°	2.1	2.5	¾
Service Extensions—					
Direct heating....	160,000				
Mains and risers.	20,000				
	180,000	100° to 180°	30	18	2
Dairy water supply	50,000	165°	8.3	5	1¼
Direct heat'g coils.	15,000	180°	—	1.5	¾
Hot water urn...	25,000	180°	2.1	2.5	¾
Book Hall Extensions—					
Direct heating....	162,000				
Indirect stacks...	365,000				
Tempering coil..	396,000				
Air moistening..	180,000				
Mains	50,000				
	1,153,000	100° to 180°	192	115.3	4
Hot water supply.	167,000	165°	27.8	16.7	1½
Turkish bath htg.	76,000	190°	—	7.6	1¼
" moist'n'g	45,000	190°	9	4.5	1
Stable Buildings—					
Direct heating....	180,000				
Mains and risers.	20,000				
	200,000	100° to 180°	33.3	20	2
Hot water supply.	55,000	165°	9.2	5.5	1
Kitchen boiler...	33,000	165°	5.5	3.3	¾
Greenhouse—					
Direct heating....	915,000				
Direct htg. cot'ge.	73,000				
Mains	50,000				
	1,038,000	100° to 180°	173	103.8	4
Mushroom Cellar.	25,000	100° to 150°	—	.4	¼
Men's Lodge—					
Direct heating...	75,000	100° to 180°	12.5	7.5	1¼
Hot water supply	33,000	165°	5.5	3.3	1
Gardener's Cottage—					
Direct heating....	36,000				
Mains	4,000				
	40,000	180°	—	4	1¼
Bailiff's Lodge—					
Direct heating....	75,000				
Mains	15,000				
	90,000	180°	—	9	1½
Future Appliances.	150,000				
Total..........	4,697,000			467.6	
Tax at one time..	4,000,000			400	

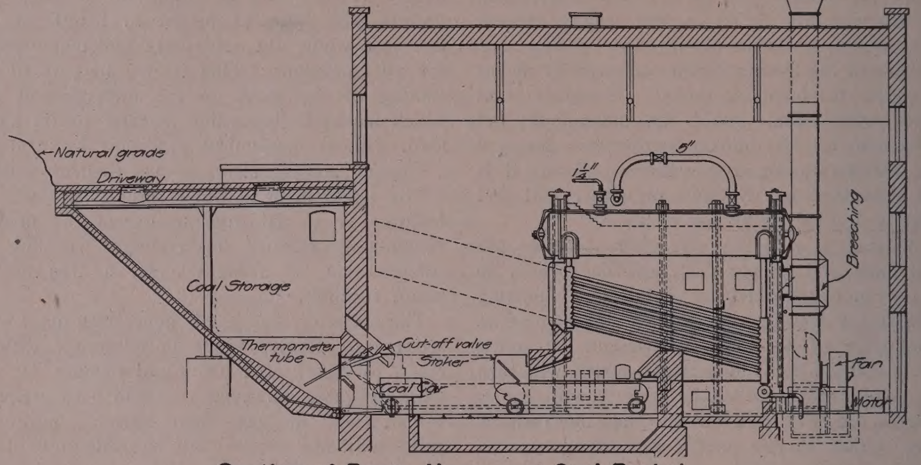
The entire equipment of the station outside the boilers and the electric generators is placed in a moderate-sized room, adjoining the other two on the same level. There is no cellar to the building, and no trenches in the engine and pump rooms, outside the underground conduits for the heating mains. The apparatus in this room includes two circulating pumps and the converter for the heating system, two feed pumps, and the combination heater and receiver. This apparatus is grouped to permit easy inter-connections, with all pipes, valves and fixtures readily accessible, and everything superfluous eliminated. The piping in the engine room is equally simple and clear cut. Reserve has been provided only in the vital parts, and as far as necessary to maintain apparatus in the proper condition for efficient service.

The Central Heating System.—The schedule of the heat appliances gives an idea of the character and variety of the heat service. The site plan shows the scattered location and distances to points of delivery, while the load diagram previously referred to approximates the tax for any time of the day, and shows that nearly the total of all appliances is likely to be in use at one time during certain hours. The method of laying the underground mains between buildings is the familiar one shown by the details.

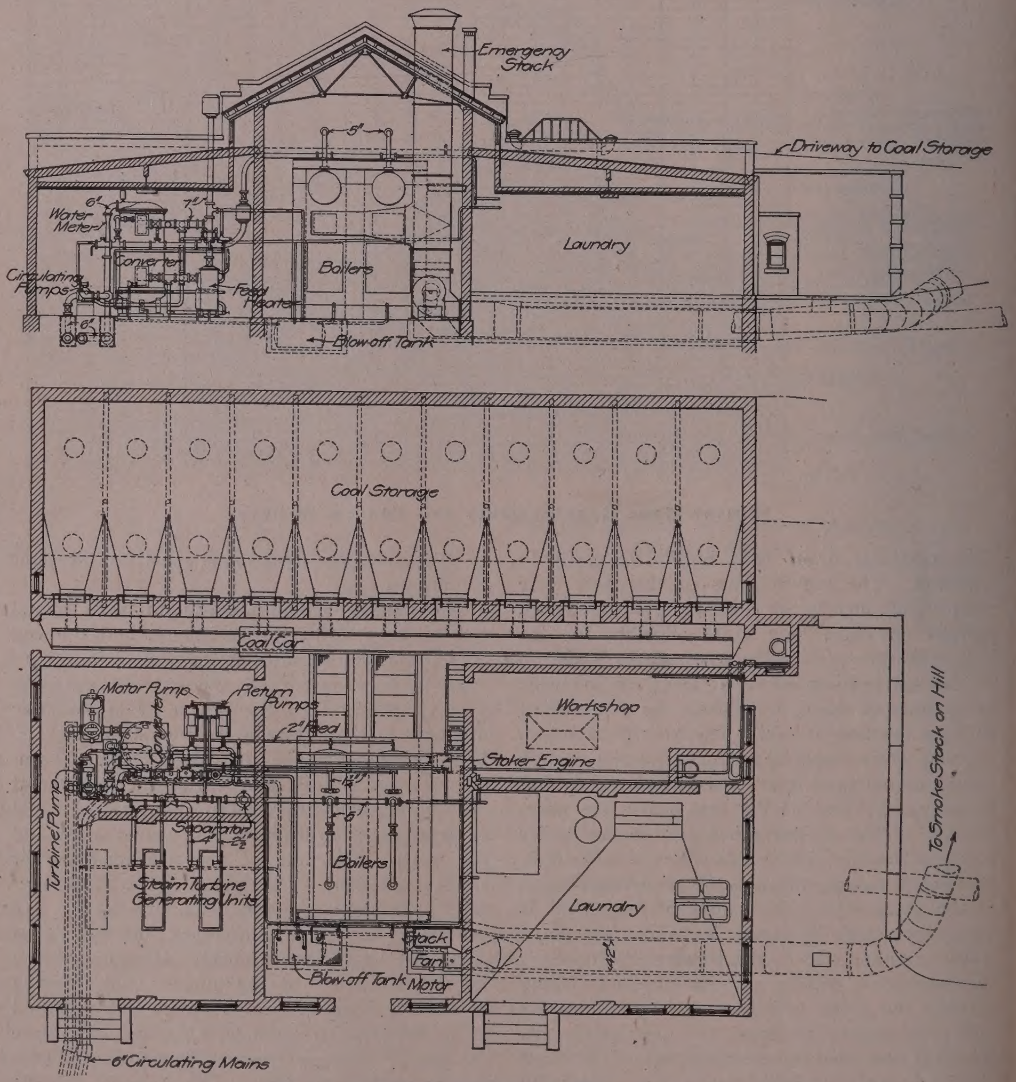
For heating the various buildings it was desirable to utilize the existing gravity hot water heating plants, as for instance in parts of the residence and the greenhouses. Where new heating apparatus had to be installed it was designed also on the gravity plan, independent of the forced circuit, that is, with secondary circulation, receiving heat from the central plant, but no water. This was done for several reasons. First, to permit easy variation of the temperature of the heating surfaces in rooms, to suit the weather, without changing materially that of the heat carrier, which must be kept up for other apparatus. It may be said, that lower water temperature in individual apparatus might be secured by throttling on the main. If, however, the distribution of heat within the building is by gravity, the circulation would be unbalanced by the forced inflow under varying head. This disturbing effect could be neutralized by an intervening tank, but such a tank would cause an undesirable increase in the water contents of the system. Second, the separation reduces the static water pressure on the apparatus in each building to that due to its own height. Third, it keeps down the bulk of water contents in the forced system as far as possible, with the idea of reducing the expansion. The separation of the heat carrier, being nearly at uniform temperature, permitted the daily fluctuation to be taken up by a tank of moderate size and with the least chance of disturbance. This was especially desired in the present case since the high point of the system happens to be within the residence. Fourth, the separation tended to minimize the chances of leaks on the circulating system. Fifth, it made it feasible, through confining the forced circuit to the cellars, to keep it at a lower level and to seal it, so to speak, by a stationary column of cooler water, thereby permitting a higher flow temperature to be carried without risk of steaming.

Secondary gravity circulation was accordingly used in all cases where a variation of the temperature of heating surface is desirable, that is, for heating the various buildings, the apparatus for which permitted also the greater bulk of water to be separated from the forced system. Direct application of the heat is resorted to in two of the minor buildings, where pipe coils could be used, and control of the heat by the throttling was deemed proper. The hot water supply boilers, of course, could not be connected directly to the forced system for obvious reasons. The heat is transmitted by coils as customary with steam service. For the gravity heating system similar coil heaters were designed, on the lines of a closed water tube feed water heater with spiral brass coils for the water from the central station, arranged so as to insure a positive circulation, as far as possible on the "Gegenstrom" principle.

It was calculated that the highest temperatures required on the gravity apparatus would be about 180° F. on the flow, and 140° on the return pipe, giving a mean temperature in the coil heaters of about 160° F. The amount of heat necessary to maintain this is to be transmitted by the forced system under a drop of 20° F., and at a maximum flow temperature of about 210° F., or a mean of 200° F., although the static head of water would permit heating it higher. The difference of mean temperature therefore, to be kept up in coldest weather between the primary and secondary circuits was expected to be not more than 40° F. The heat transmission from water to water, for brass coils, was estimated under these conditions to take place at a rate of 200 B.t.u. per square foot per degree, or about 8,000 B.t.u. for 40° F. Allowing for the uncertainties in the distribution of water, and of heat loss in transmission, the coil surfaces were figured on the basis of only 6,000 B. t. u. per square foot. In the hot-water supply tanks, where the ordinary wrought iron pipe coils are used, the coefficient of transmission was expected to be somewhat smaller, but on account of the lower mean temperature of the water supply, about 120° F., the



Section of Power House and Coal Pocket.



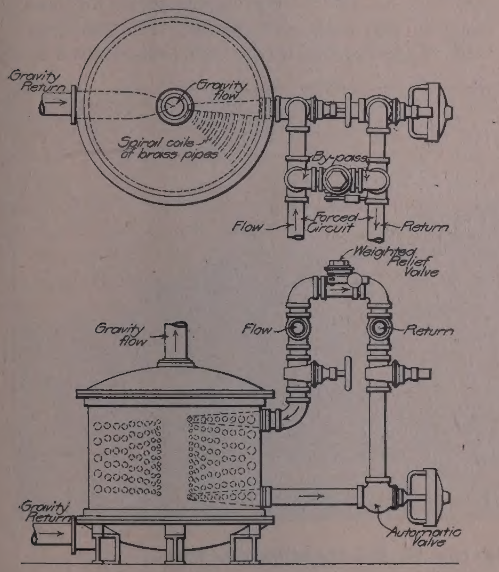
Plan and Cross Section of Power House.

same actual rate of 6,000 B. t. u. was assumed.

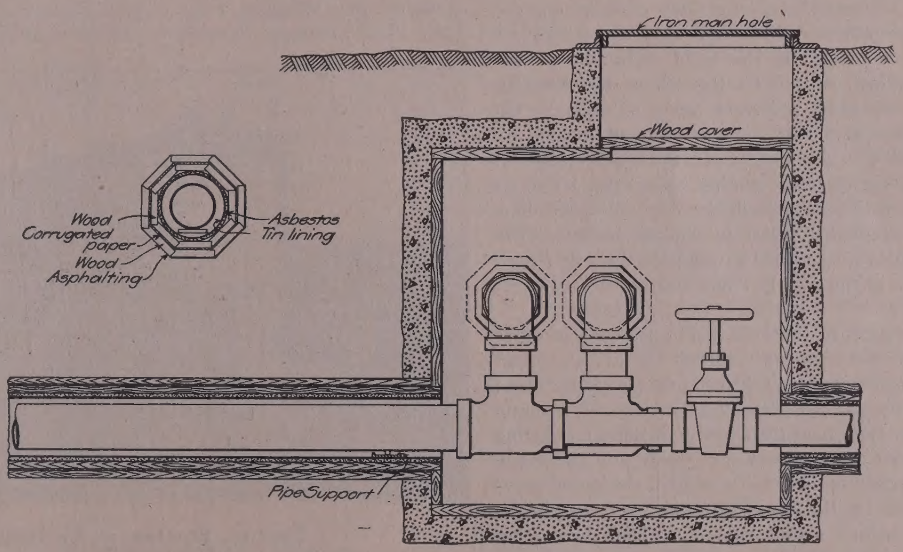
The records of operation show the actual difference between the primary and secondary circuits to be 35° F. at full load, and less than 30° F. for average conditions. The estimated rate of transmission seems, therefore, to be conservative, inasmuch as the amount of water circulated checks practically with the calculations. The drop at full tax on the coil heaters is about 20° F. as figured, and averages about 15° F. for ordinary conditions.

One of the appliances made a part of the forced circuit is a coil for tempering an underground mushroom cellar located about 500 ft. from the main heating line at the greenhouse. The amount of heat required is very small and might have been provided at less expense by an independent stove. The connection with the central station was desired with the idea of avoiding smoke and coaling. A coil around the beds was also preferable for distributing and maintaining an even heat. Inasmuch as the water temperature would just as well be kept lower, it was possible to work under a greater drop. With 50° F. difference between flow and return connections at the main, the water in its course through the coil would still average about 150° F. which was considered amply high for the purpose. This reduces not only the amount of water needed, but also the actual loss in transit. Instead of one gallon per 10,000 B. t. u., only one 0.4 gal. is required, and the friction head is thereby reduced to about 0.16 times that for 1 gal.

The heat tax, including loss in transit, was estimated to be 25,000 B. t. u., requiring 1 gal. of circulating water per minute. The differential head, at the junction with mains, was estimated to be about 6 ft. under full speed, and the size of branch line which would equal this loss of head for approximately 1,000 ft. length, was found to be only ¾ in. Although apparently very small for a run of such length, the calculated size was adopted, inasmuch as a lower pump speed still promised sufficient heat. The pipes in this case are run in a single tile conduit and wrapped in asbestos paper. The cost of installation was thereby kept within reasonable limits.



Coil Heaters for Secondary Circulation.



Conduit Construction and Typical Manhole.

The primary or forced circuit connects also directly with various other devices, such as a plate warmer coil and the hot water urns with double bottoms, a sort of fireless samovar or teakettle. These urns are fitted with an auxiliary electric device to be turned on for quick boiling, since the circulating water, although under greater head, can not be depended upon to boil the water in the open kettle even at 200° F. for that altitude. Other devices in connection with a Turkish bath, like the entire hot water supply service, are in use throughout the year. The greenhouse also needs tempering in that climate on cool nights at almost any season, so that it is necessary to keep up the circulation steadily, at a flow temperature of about 180° to 190° or just high enough for the water supply and to be raised only on cold winter mornings, when the water temperature in the gravity heating apparatus must be higher than 150° F.

The heat delivery to all the important appliances is put under automatic control, the idea being to shunt off the forced flow through a bypass with a weighted relief valve as soon as the water in the gravity systems or in the hot water supply reaches the desired degree. This is done primarily to avoid over heating, and also to save fuel by keeping the excess heat within the well-insulated pipe lines of the circulating system. The method of making the connections is shown by illustration. As designed, the circuit is not interrupted by shutting off one or more appliances. This assures an even temperature and more sensitive control, and makes it impossible to turn any portion of the underground runs into a "dead end" by neglect.

The problem of sending the requisite amount of water through each appliance was solved by computing approximately the resistance of the piping under the maximum flow. Assuming an initial speed of about 5 ft. per second, which would be approximated in a 6-in. main, the relative capacity of smaller pipes, figured on the basis of the same rate of friction loss, which is 1.82 ft. per 100 lin. ft. were found to be as follows:

Pipe, in.	Velocity, ft.	Loss, ft.	Gal. per min.
6	5.0	1.82	440
5	4.3	1.82	265
4	3.7	1.82	144
3½	3.4	1.82	104
3	3.1	1.82	70
2½	2.7	1.82	40
2	2.4	1.82	25
1½	2.0	1.82	13
1¼	1.8	1.82	8
1	1.5	1.82	4
¾	1.3	1.82	2
½	1.1	1.82	1

The circulating system was proportioned on this basis with allowance for length of runs and obstructions. The total head for flow and return, including the resistance in the heater and appliances, figured about 90 ft. between pump inlet and outlet by way of the far end of the circuit for a delivery of 400 gal. per minute. The connections closer to the pump were then given sizes to approach the same resistance head, so as to equalize delivery. Key valves were provided on all connections to permit more accurate adjustment and control of the flow, if necessary. The results observed in actual service indicate that under a friction head of about 90 ft., as calculated, the delivery of the pump is only 380 gal., instead of the expected 400 gal., or, when driven up to that capacity, the friction head indicated by manometer exceeds a water column of 90 ft., as estimated. This discrepancy was practically accounted for by a number of extra bends on the main, found unavoidable in construction, also by greater actual length of runs than that estimated. The distribution, however, was not appreciably affected, and no further adjustment of the flow was needed.

The heat losses in transit, as indicated by the difference of temperature at the extreme ends of the line, and by the rate of flow, were found to vary but little as to actual quantity, but representing, of course, a greater percentage when under light load.

The temperature drop for the branch leading up the Glen, a 5-in. line 1,500 ft. long, averages 1° F. each way at full speed. For the 4-in. branch to the greenhouses on the lower end of the system, 2,100 ft. distant, the drop at full speed is 2° F. At half speed the drop is nearly twice as much under the same conditions. In coldest weather, when the full heating tax causes a drop of 20° F. at the buildings, the difference to be maintained at the central station is, therefore, about 23° F., and the loss of 3° F. represents 13 per cent. of the total output for the whole system. At half speed, the actual heat loss being nearly the same, the proportionate loss is about 20 per cent. A slightly higher rate of loss maintains when the speed is kept up in warmer weather, with a smaller difference between flow and return. Naturally that rate is greater in proportion for the 4-in. main, and less for the 5-in. line. In fact, owing to the heat developed by friction the drop in the latter part, at full speed, often practically disappears, while the 4-in. line shows more at times, as it passes through wet ground. Taken as a whole, the average loss for the year is probably not much over 15 per cent. of the output, since the rate of heat convection is decidedly smaller in warm weather. This loss is about balanced by the greater efficiency of a single up-to-date boiler plant, which has the additional advantage of utilizing a much cheaper fuel.

Individual Heating Apparatus.—The dryness of the air in that locality accentuates undoubtedly certain disagreeable and unwholesome effects of modern heating systems. Moisture separates more quickly from the solid particles in the air and becomes more irritating to the mucous membrane. The higher the temperature of heating surface, the more dust particles are thrown off, or singed and turned into offensive gases. This vitiation of the air by heating apparatus, which is more objectionable than the mere drying effect, accounts to an extent for the habit, grown out of the strong desire to open windows, to give life to the air, even though no other source of pollution is present. It was desirable, therefore, to supply the requisite amount of heat with the lowest practicable temperature of radiating surfaces, variable, and kept no higher, at any time, than necessary for comfort.

Direct radiation was installed, except in rooms used largely for entertaining and where windows had to be shut at such times. The fresh air brought into these rooms by the indirect system is slightly moistened on its passage between the tempering coil and the heating stacks. The pans for evaporation are heated by coils on the gravity system, giving vapor about in proportion to the need; that is, more in cold weather when the circulation is brisk, and less in mild weather, thus supplying approximately the deficiency caused by the renewal of air.

Automatic heat regulation for the individual rooms of the residence was desired, but thought impracticable owing to the liability to open windows and doors, the direct and very strong influence of sunlight and the substantial character or heat-retaining qualities of the house itself. The greater promise of comfort lay in continuous heating regulated centrally as to intensity, to suit the need, with the idea of warming the solid structure rather than the air itself and gaining comfort by the mild radiation of the surrounding walls. To this effect the shutting off of individual radiators was discouraged. On the other hand, the most convenient means are provided to raise and lower the water temperature of the gravity heating apparatus. This is done by a thermostatic device controlling the flow of the circulating water to the coil heaters. The same apparatus is used to regulate the water temperature in the supply tanks and in various other appliances.

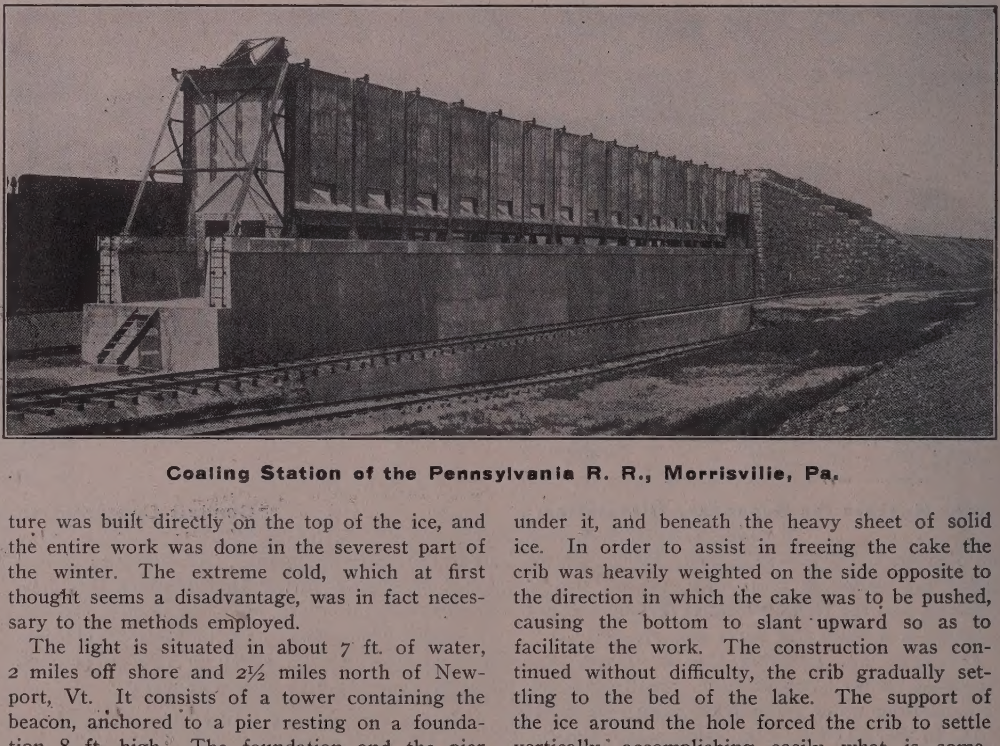
The design of the individual apparatus in other respects contains no unusual features, except that special care was taken to provide ample, clean and easily accessible heating surfaces. A vacuum cleaning system is installed to assist in reducing dust about the residence and stable to a minimum.

Recording Devices.—To control the actual service given by the central station, and to put its operation on a sound economical basis by tracing and checking all unnecessary waste, a series of recording devices have been installed, which would prove a paying investment for many central or individual plants. These instruments are additional to the ordinary thermometers and gauges and incidentally verify their readings.

To induce efficient service it is desirable to know whether the proper temperatures on the forced and gravity systems have been kept up. For this purpose recording thermometers are used on both flow and return pipes near the reheater, also on the secondary coil heater of the gravity system for the residence. The pressure carried on the boilers at any time is shown by a similar record, which reveals plainly all incidents and irregularities of operation.

To secure the best results in the operation of the boilers, which depend largely on the proper combustion or utilization of the fuel, recorders are used to show the flue temperature and the percentage of CO_2 in the gases. These two factors in combination give clear evidence whether the speed of the stoker is properly regulated, the draught being controlled to keep up a constant steam pressure. An excessive amount of air passing through the grate is at once shown by a lower flue temperature combined with low percentage of CO_2 while low flue temperature alone, with the proper amount of carbon dioxide would indicate that a light fire had been carried properly for a light load.

As a matter of bookkeeping, record is being kept, of course, of the coal consumed. The amount of fresh feed water used is also registered. In order to balance the input of the plant with the output, it has been proposed also to record the flow of water passing through the forced circuit, by means of a charting device attached to the Venturi tube which now only indicates the rate of flow. The amount of water circulated and its differential temperature give the output in heat from the station. The wattmeters state the output in electricity. The live steam used in the laundry and various purposes about the power house is recorded by a condensation meter inserted into the return pipe. The fresh feed water, measured separately, pretty nearly represents the waste of steam escaping through the roof, usually avoidable, and the greasy drips and blow-off from the boilers, which are a necessary loss. The output of the station in B.t.u. can thereby be closely established and balanced against the thermal value of the fuel actually burned.



Coaling Station of the Pennsylvania R. R., Morrisville, Pa.

The Construction of the Whipple Point Beacon.

The U. S. Light House Establishment during the past winter rebuilt by the use of interesting methods the Whipple Point Light Station in Lake Memphremagog, Vermont. The new structure was built directly on the top of the ice, and the entire work was done in the severest part of the winter. The extreme cold, which at first thought seems a disadvantage, was in fact necessary to the methods employed.

The light is situated in about 7 ft. of water, 2 miles off shore and 2½ miles north of Newport, Vt. It consists of a tower containing the beacon, anchored to a pier resting on a foundation 8 ft. high. The foundation and the pier are of standard design, consisting of a rock-filled timber crib, the lower part forming the foundation being 20 ft. square, and the upper part being a truncated pyramid 10 ft. high, with a base 20 ft. square, and a top 12 ft. square. The stone filling is composed of rocks weighing from 20 to 200 lb., and larger pieces weighing from ½ to 1 ton and over are used as rip-rap on the outside of the foundation.

The construction of the crib was originally planned for the summer months, but when the various items of expense were considered, the cost of doing the work at this season was found to be excessive. Wagons would have to be used for hauling the stone from farms near the lake, and the loads consequently would be small; the cost of loading into wagons would be a large item, and the difficulty of getting the teams down to the water's edge was very great on account of the high, precipitous banks. Even when the stone was delivered on the shore, the problem was far from solved, for there were neither piers for loading nor scows for transporting the material. It was therefore decided to do the work in the winter, and when 5 ft. of ice had formed on the lake the work was commenced. The stone was hauled over the snow to the edge of the high bank on stone sleds, made of heavy plank laid flat and securely fastened together. One horse could do the work which required two in summer, and the loading consisted merely in rolling the stones onto the sleds. At the top of the bank the stones were rolled over the edge and allowed to tumble down the slope and accumulate on the ice. Here they were rolled onto sleds similar to those used on land, and hauled to the site of the beacon. All the timber used in the work was dragged over the snow and ice.

The crib was built directly on the ice over the spot selected for it. After the structure was sufficiently advanced and the proper amount of stone had been placed in it to cause it to sink partially, the ice around the edge of the foundation, and as near the latter as possible was cut through, and the entire mass allowed to settle. The work of construction was continued and the structure sank gradually as its weight increased. When the bottom of the foundation reached the level of the under side of the solid ice, holes were cut alongside the floating crib, pike holes were inserted and the square cake of ice supporting the crib pushed out from under it, and beneath the heavy sheet of solid ice. In order to assist in freeing the cake the crib was heavily weighted on the side opposite to the direction in which the cake was to be pushed, causing the bottom to slant upward so as to facilitate the work. The construction was continued without difficulty, the crib gradually settling to the bed of the lake. The support of the ice around the hole forced the crib to settle vertically, accomplishing easily what is sometimes a difficult problem.

Though the entire weight of the partially completed structure and as much as 50 tons of rip-rap at times rested on an area not more than 60 ft. square, no settlement or cracking of the ice occurred. The work was frequently interrupted by severe weather, due to high winds, though when there was no wind work was carried on with the thermometer as low as — 30°. The work was started on Jan. 29, 1907, and was finished in two months. The total cost, $1,490, was estimated as one-third to one-half of what it would have been had the work been done during the summer.

The beacon was built under the direction of Major Charles L. Potter, U. S. A., engineer of the Third Lighthouse District, and under the immediate supervision of Mr. W. Gray Verner, superintendent of lighthouses. The contractor was Mr. E. R. Goodsell, Alburg, Vt.

The Coaling Station of the Pennsylvania Railroad at Morrisville.

The Pennsylvania R. R. Co. has recently completed at Morrisville, Pa., a coaling station of steel and reinforced concrete. But little of the steel is visible and the concrete surfaces have been brushed with a thin coat of cement in order to give them a smooth surface. The total length of the structure is 204 ft. and the height above the lower coaling track 31½ ft. Its length is divided into a laborers' room of 24 ft., a sand bin of 12 ft., and the 500-ton coal bin of 168 ft.

The superstructure containing the coal bunkers is carried on two concrete pier walls running the whole length of the structure. These piers are 16½ ft. high above the bottom of the foundations, and 12½ ft. above the base of rail of the lower coaling track. They are 7 ft. 9 in. apart at the base, and 11½ ft. at the top between the inside faces of the coping.

The bunkers are 14 ft. wide, and the distance from the ridge of the sloping floor to the bottom of the cross girders at the top of the bin is 7 ft. 6½ in. The total depth of the bunkers from the base of rail of the upper track to the lower edge of the sloped floor at the discharge openings is 15 ft. 9 in. The height of the bunkers above the coping is 19 ft.

The weight of the superstructure and its contents is carried to the pier walls through columns in both faces of the station, spaced 12 ft. apart for the entire length. They have a 10 x 5/16-in. web, and four 5 x 3½ x 5/16-in. angles. Connecting them just above the pedestal shoes is an 18-in. 55-lb. I-beam, to which are connected the horizontal ties and inclined girders in the bottom of the bunkers. Across the top of the panels in the face of the station and connecting the columns is an 8-in. 11¼-lb. channel, with legs pointing downward. In each 12-ft. panel is an opening 3 ft. high and 5½ ft. wide for the discharge of the stored coal. The end of the inclined bottom of the bunkers coincides with the bottom of the opening, and rests on the top of the 18-in. I-beam spanning the bottom of the panel. The sides of the opening are made of 8-in. 18-lb. I-beams which rest on the 18-in. beams and run the total height of the panels.

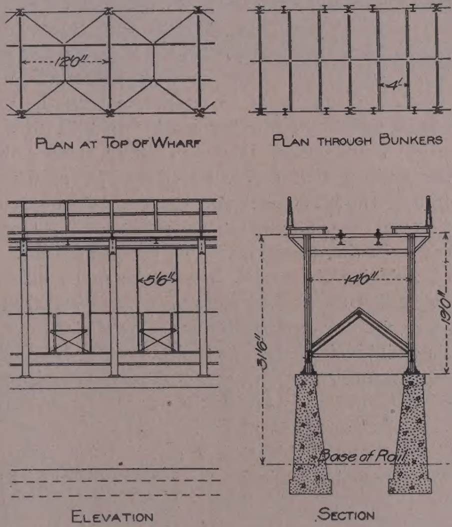
The side walls between these vertical beams and the columns are reinforced concrete. There are three sections to each panel, two of 3 ft. 3 in. each, and the third having the width of the discharge opening, 5½ ft. The slabs are made of 3 in. of 1:2 ½:5 concrete with a 1-in. granolithic finish on the inside of the bins. Expanded metal of No. 16 gauge and 2½-in. mesh constitutes the reinforcement.

The bottom of the bins slopes from the center downward to each face of the structure at an angle of about 37 deg. with the horizontal. The inclined girders supporting the bottom are built of two 9-in. 13¼-lb. channels placed back to back. Beneath the bins and riveted to the 18-in. I-beams which span the bottom of the panels, are two horizontal 3 x 3 x 5/16-in. angles, which act as ties and connect the lower ends of the two inclined girders in the same vertical plane. The girders are 4 ft. apart on centers. Connecting their upper ends and normal to their direction, after the fashion of a ridge pole, are two 3 x 2½ x 5/16-in. angles. The floor between the inclined girders is composed of 1:2½:5 concrete slabs 6½ in. thick, reinforced by expanded metal of No. 10 gauge with 3-in. mesh, and finished with a 1-in. granolithic covering, used on the inside of the bins on account of its excellent resistance to the abrasive action of the sliding coal. There is no steelwork exposed in the inside of the bin, the plans requiring at least 1½ in. of concrete around the metal.

The columns are connected across the bin by plate girders 2 ft. 6½ in. deep, with 6 x 4 x 9/16-in. flange angles. Between these girders are two smaller plate girders 4 ft. 11 1/16 in. apart, which act as stringers carrying the rails of the track. The latter girders have 18 x ⅜-in. webs and four 5 x 3½ x 7/16-in. flange angles. Standard Pennsylvania R. R. rail clips fasten the 85-lb. rail to the girders every 2 ft. These girders are braced to prevent side swaying by a 3 x 2½ x 5/16-in. angle running from the outside center of each girder to the columns, and by a 12-in. 31½-lb. I-beam between the two girders at the center of the span.

Foot walks for the men operating the incoming dump cars are built over the side walls along the full length of the coaling station. One half of the walk extends beyond the wall and is carried on a cantilever bracket at each column. A suitable iron guard railing runs along the outside of the walk. A bumper made of steel shapes and a simple form of end bracing is used at the end of the station.

At the incline end, two of the panels are occupied by a laborers' room, and at the opposite end, beneath the sand bin, is a small office. Access to the laborers' room is furnished by a ladder, as the space between the track and the station would not allow of a stairway. The approach to the office is by a stairway leading to a landing between the piers and on a level with the office floor.


Plan at Top of Wharf
Plan through Bunkers
Elevation
Section

Details of Coaling Station.

The incline for the loaded coal cars is on an earth fill terminating at the station in a stone abutment. This abutment for some distance back from the face is U-shaped and accommodates only a single track. In order to give access to the lower coaling track from both directions, a curve starts opposite the face of the abutment. When the track has departed sufficiently from the center line of the elevated track to justify it, a wing wall is started and carried back approximately parallel to the curved lower track.

The structure was designed in the office of Mr. Joseph T. Richards, chief engineer of Maintenance of Way, under the supervision of Mr. Richard G. Develin, assistant engineer.

A Gas Turbine of the Lemale and Armengaud continuous-combustion type of about 600 h.-p. has been running for some time in the shops of the Société des Turbomoteurs at Paris. Its speed is 4,000 r.p.m. and it drives a Rateau and Armengaud multistage turbo-compressor. The speed regulation is effected by throttling the air admission for small speed variations, and by a change in the fuel supply for larger changes, the regulating valves being controlled by a Hartung governor.

Railway Location Economics.

In the account of the recent convention of the American Railway Engineering and Maintenance of Way Association printed in this journal on March 30, mention was made of the special attention paid to the report of the Committee on the Economics of Railway Location. It is not at all surprising that this 104-page document attracted attention for the committee making it consists of Mr. W. McNab, assistant engineer, Grand Trunk Ry., chairman; Prof. W. D. Taylor, chief engineer, Chicago & Alton Ry., vice-chairman; Prof. C. Frank Allen, Massachusetts Institute of Technology; Mr. J. B. Berry, chief engineer, Rock Island system; Mr. V. G. Bogue, general manager and chief engineer, Western Pacific Ry.; Mr. J. F. Burns, roadmaster, Louisville & Nashville R. R.; Mr. W. W. Colpitts, assistant chief engineer, Kansas City, Mexico & Orient Ry.; Mr. W. L. Darling, chief engineer, Northern Pacific Ry.; Mr. W. E. Dauchy, Chicago; Mr. Lewis Kingman, chief engineer, Mexican Central Ry.; Mr. O. E. Selby, bridge engineer, Big Four system; Mr. W. B. Storey, Jr., chief engineer, Santa Fe system; Mr. F. L. Stuart, chief engineer, Erie R. R., and Prof. Walter Loring Webb, Philadelphia. The report of this committee is much too long to review in a single article, so it is proposed to take up in this and succeeding issues some of the subjects it covers that are of most interest. It should be understood at the outset that the commitee's report is one of progress only. The committee was formed to investigate all questions connected with railway location, grades, lines and improvements of grades and lines affecting the economic operation with relation to traffic, tonnage ratings, speed, density of traffic and financial considerations, with the special aim in view of establishing uniform methods and unit values for investigating and analyzing the relative changes and costs of comparative routes or proposed grade reductions and line corrections. This program is so important and varied that the committee decided to devote its attention at first to gathering and arranging data, reserving for a later date the formulation of rules to cover any of the topics within its province.

It may be said generally that, viewed from a modern standpoint, much of the railway construction in the early days of the development of North America was of an inferior character. Great distances had to be traversed, the population of the country was sparse and scattered, and the gradients and curvature were, therefore, too frequently determined by the amount of money to be expended per mile of road, rather than by a consideration of the probabilities for future traffic and the economic value of grade and alignment features. Commercial progress of the country, however, followed the introduction of the railway, and the financial problem of how to make a dollar earn most, began to receive greater consideration. For a number of years past, the larger railway organizations have been spending large sums of money in improving the properties under their charge; but while there has already been an immense outlay in this respect, it may be said confidently that betterments in the future, both in new locations and in revision work, will be on a much greater scale than those of either the past or present.

The general situation necessitating such changes may be said to be the outcome of circumstances. It is due in a great measure to a realization of the saving in operating expenses resulting from such betterments, to the increasing demand for cheaper rates and better service, the competition of railways with one another, and, more especially, to the construction of new lines designed on better economic principles. In the effort to reduce train mileage, locomotives and rolling stock generally have been greatly increased in size, weight and capacity and the effect of such changes has been: Bridge structure of increased strength, heavier rails, securer joints, more and better ballast, wider roadbed, and, consequently, an improved railway. Besides changes of this nature, however, it soon became recognized that many improvements might be made in the distance, gradients and alignment of the earlier construction which would effect a reduction in train mileage, independent of the class of rolling stock used.

It is usually comparatively easy to estimate the cost of a projected railway or an improvement to an existing one. The actual cost, however, of operating such a line, or the value of the saving in operating expenses which is rendered possible by any proposed physical change in the road or in the method of operating its trains, due to a modification of alignment, distance, or gradients, is more uncertain.

Before the proper location or re-location of a railway can be decided intelligently, it is necessary that the factors governing its earning power be properly understood, and the relation between the purely engineering and the financial features thoroughly grasped. Railways are built as commercial undertakings for profit, and a railway that can furnish the most economical transportation, time as well as money being considered, will finally show the best net earnings.

The three principal factors which affect profits, viz., gross earnings, operating expenses and fixed charges, are, in a great measure, dependent upon the location of the road with regard to the sources of traffic. With a gross amount of traffic and proper location and construction, the greater the first expenditure (with its consequent improved road) the less will be the operating expenses, but the greater the fixed charges. Increasing one decreases the other. With a given volume of traffic, the economic location is the one in which the sum of fixed charges and operating expenses is the least; and a more economical location is obtained when interest and renewal charges on additional expenditure for construction are saved in decreased operating expenses, or when increased operating expenses are saved in reduced interest and renewal charges on cost of construction. The most economical location is secured when every gain possible has been effected, both by decreased cost in the one case and decreased operating expenses in the other. In grade reduction, it is the saving in number of trains, even if each train costs somewhat more.

The effect of differences in location on such factors must be understood before a proper and economic location can be determined. If it can be computed that by certain physical alterations in alignment or gradients, or by any change in the method of operating trains, the expense of each train over a proposed line or the number of trains to handle a given traffic can be reduced, then the only problem remaining is the financial study of the relative values of the proposed expenditure and the expected annual saving. A general and purely academic discussion of some features of this question may profitably precede the future consideration of details.

It is often stated that any really meritorious proposition can command the requisite capital, provided that it is properly exploited. Although there is considerable truth in this statement, it is also true that there is a wide difference in the amount of effort necessary to raise money, depending on the status of the corporation making the effort. It is perhaps unfortunate that the financial standing of many railroad corporations is so unlimited, that many changes, which probably could not be justified by any rational method of computation, are recklessly made after slight consideration. There may be little or no reduction in operating expenses, and certainly not enough to justify the capital expenditure, but the financial strength of the company is so great that there is no reduction in dividends. There may be an actual increase in dividends, which only means that the financial strength of the road is so great and growing so rapidly, that the comparatively insignificant loss due to fixed charges on an unjustifiable expenditure is utterly swallowed up. On the other hand, the road which is financially weak must show unquestionable justification for any proposed improvement, and even then the financial reputation may be so limited that a really meritorious project may fail for lack of funds.

There can be no question regarding the justification of providing for traffic that may reasonably be expected for a considerable period after the plans are made. A railway is not built for a day's work. There will be an interval of a year or more after the plans are made before the road is built. Several years more may elapse before the normal traffic is obtained. If the increased traffic cannot be economically handled with the facilities provided, then the railway is confronted with the choice between an uneconomical handling of traffic or an immediate additional expenditure with its accompanying loss and waste of work already done.

Of course, much depends upon the character of the change and the amount of the waste. In territory where the topographical features are extreme and the financial aspect a governing element, cases may arise in new construction in which it is necessary to temporize with the profile in regard to limiting grade; that is, to construct a temporary line with grade steeper than the limiting one, a line which will be used until future traffic conditions warrant the construction on the alignment as projected. In such cases, in the consideration of the economic value of reducing the grade, it must be taken into account that the cost of any temporary work thrown away must eventually be borne by the permanent line. This fact should emphasize the desirability of avoiding temporary work whenever the finances of the company warrant the immediate construction of the permanent line.

It is conceivable that a considerable improvement may be made by merely heightening a fill in a sag without altering the horizontal alignment. The additional work in this case will cost but little more than it would have cost originally, with the advantage of saving several years' interest on the added cost. In the other extreme it might be necessary to abandon utterly a considerable section of the line, and in such case the road would become perpetually burdened with an interest charge on both lines. The very patent fact that improvements, especially when not planned during the original construction of the road, so frequently require the abandonment of considerable old work the cost of which will be perpetually represented in the fixed charges, causes a delay in the reconstruction for a number of years until the disadvantages of uneconomical operation become so great as to be intolerable.

The possibility of permanently utilizing the temporary line as a branch line, or even as a mere freight track by which to reach factories and other industries, may exclude all permanent loss from the question. It may happen that the line can be used to handle the local traffic, and one more direct for through business built later; the temporary line could then be used as a second track if the gradients are favorable in one direction. The cheap temporary line serves its original purpose and saves the immediate construction of the expensive permanent line, and yet both the preliminary and the later expenditure are fully justified by their utilization.

As a practical result, it may be taken for granted that a much heavier traffic is needed to justify the abandonment of a temporary line than would justify the construction of a permanent line designed for heavy traffic.

A very interesting collection of figures has recently been brought to the notice of the Committee. A section of the road over 83 miles long was built originally with very sharp curvature and heavy grades in order to reach certain coal fields. It was considered imperative to reach the coal fields at once, and therefore the construction of an alternative shorter low-grade line was deferred. About two years ago, the low-grade line was completed, at a cost of nearly five million dollars for 59 miles of road. Over 24 miles of distance is saved by the new line. The limiting grade against east-bound traffic has been reduced from 0.91 to 0.05 per cent. The limiting westbound grade on the old line is 1.15 per cent. On the new line, with the exception of a 0.24 per cent. grade on the approach to a bridge, there is no grade against westbound traffic. The total rise against eastbound traffic was reduced from 687 to 69 ft., and against westbound traffic from 438 to 17 ft. The maximum rate of curvature was reduced from 12 to 6 deg., and the total curvature from 19,783 to 5,075 deg. The average degree of the curve was reduced from 7 deg. 50 min. to 3 deg. 19 min. This required 10,222 ft. of tunnels as against 4,096 ft. on the old line. In this case, however, the old line was not abandoned. It is still used for trains of eastbound empty coal and coke cars. But all the westbound business and also the eastbound time freight passes over the new line. The two lines may virtually be considered as a double-track line.

The results of this improvement are given by a comparison of the business of the year 1904, handled entirely on the old line, and that of 1905, handled on both lines as described above. Notwithstanding an actual growth in business of 22 per cent., the work was done with an economy of 2 per cent. in freight engine mileage, besides the disuse of three pusher engines, with a mileage of 138,816 miles in 1904. Again, in spite of 22 per cent. increase of business, the freight train wages were actually 19 per cent. less than in 1904. On account of the relief of the congestion of the old line, the overtime of the freight trains was reduced from $80,000 to less than $43,000, a saving of 46 per cent. The average time of freight train runs was reduced from 18 hours 28 minutes to 12 hours 35 minutes, a saving of 32 per cent.

After allowing for the increase of 22 per cent. in traffic over the figures for 1904 and comparing these figures with the actual figures for 1905, it was estimated that the saving in operating expenses resulting from the construction and operation of the new line amounted to nearly $238,000, which is nearly 5 per cent. of the total cost of the new line. It is also claimed that the $238,000 does not fully measure the true saving owing to the fact that the old line was already being worked to nearly the limit of its capacity. But even accepting that figure as correct, a saving of 5 per cent. during the first year after construction may be considered a remarkable justification of the construction of the new line.

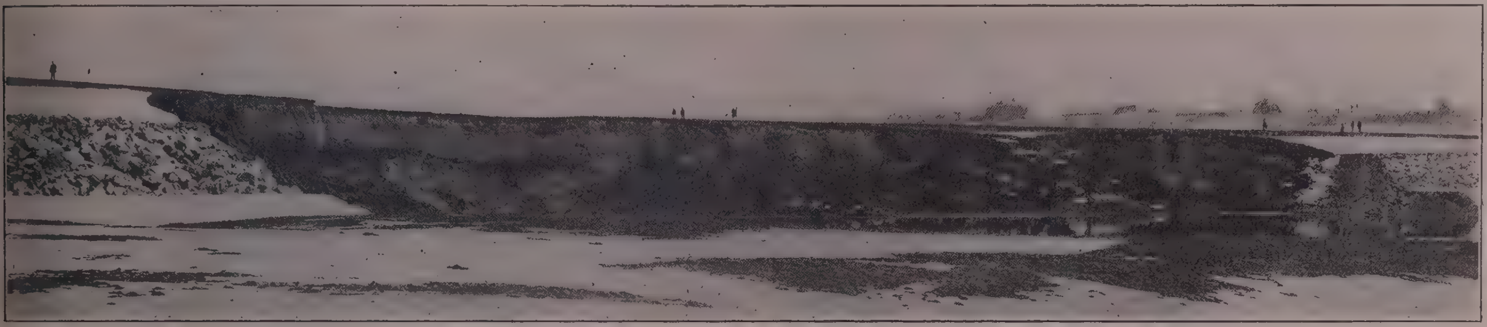
In regard to the period for which future traffic should be discounted, by the very nature of the case it varies with the character of the temporary line, the capital which will be wasted in abandoning the temporary line and the probable rapidity of growth of the traffic. It also depends upon the very variable and almost indeterminate annual loss due to uneconomical handling of traffic. Even the temporary line is supposed to be so designed that the existing meager traffic is handled as economically as is justified by such traffic. The growth in traffic is literally a growth, and does not increase by leaps and bounds. The justification of the larger expenditure changes from zero at the beginning of the period to some larger amount at which a change is imperatively demanded. Even the change, although gradual, is not necessarily at a uniform rate. There can be no empirical rule for determining the number of years in advance that it is desirable to provide for, but if the actual tonnage for a considerable period of years is plotted to form a curve, the extension of the curve will give probably the best obtainable prophecy of future traffic. Where changes can be cheaply made afterwards a small number of years seems proper, but where alterations suitable for increased traffic would mean the entire disuse of much expensive work, a much longer period in advance is advisable.

A consideration of the foregoing uncertainties will show that a definite mathematical solution is seldom possible. It would appear as if the question must be finally determined by "judgment," although the judgment should be guided by a careful consideration of all the modifying elements, and each change should be considered by itself even on the same road.

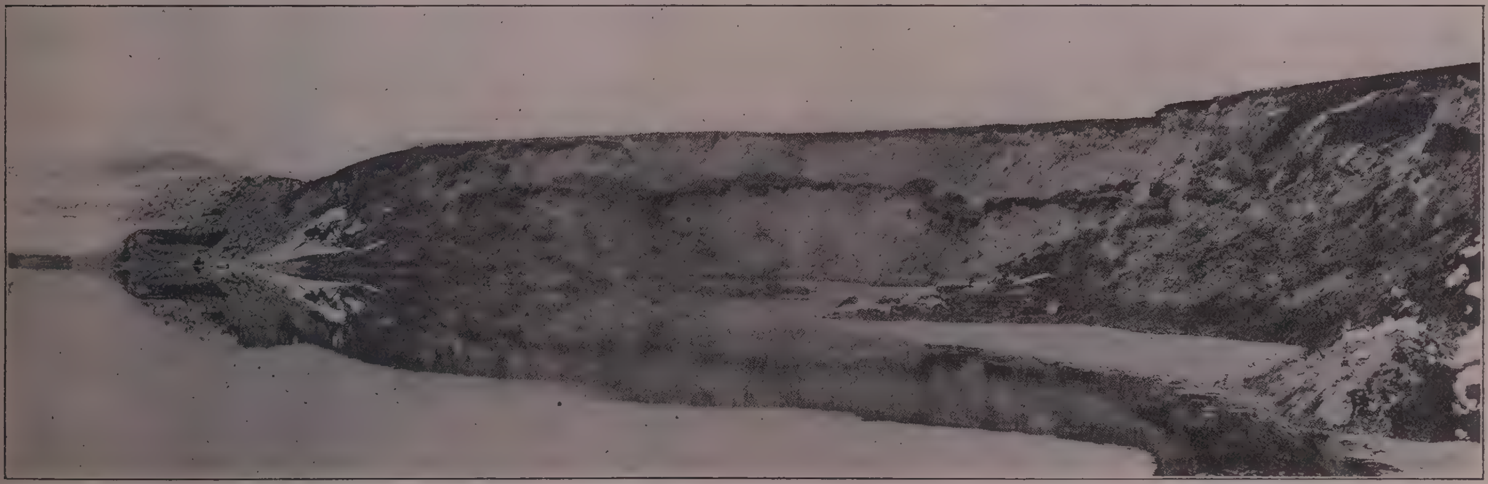
THE CHENAB CANAL in India is stated by Mr. J. Davis, Under Secretary for Public Works of New South Wales, to be the best of the irrigation works in operation in the Punjab. It embodies the result of experience of irrigation engineering in India during the last 50 years. The soil is stated to be fertile, but owing to the small rain-fall, which averages 5 in., the whole area was a desert before irrigation. Mr. Davis frequently saw land without any vegetation upon it, because it had not been irrigated, side by side with land growing wheat averaging nearly 15 bush. to the acre, and sometimes producing twice that amount. A railway has been constructed particularly to serve the irrigated land and is one of the most profitable in India. There are now 2,765 miles of main and other channels, commanding 3,194,000 acres of irrigable land. The total cost of the work was £1,873,000.

The Earth Slide at the North Dyke of the Wachusett Reservoir.

The last fortnight has seen the publication of so many newspaper reports, some of them wild exaggerations, and others flippant paragraphs, regarding a slide which took place recently on the face of the north dyke of the Wachusett reservoir at the Metropolitan water works, at Clinton, Mass., that a statement of the facts is of some importance. The character and extent of the slip are shown clearly in the accompanying illustrations. Had the slide occurred in an ordinary earth dam, not more than 40 ft. thick at the high-water line, it would have had serious results; but in a structure some 800 ft. thick at that level it was merely annoying. The construction of this dyke has been so fully described in The Engineering Record of April 9, 1898; May 27, 1899; Jan. 20, 1900, and May 24, 1902, that it is unnecessary to go into its details again, although the reason for its construction deserves repeating.



General View of the North Dyke at the Place Where the Earth Slide Occurred.



View of One End of the Earth Slide, Showing Berme and Riprap Resting on it.

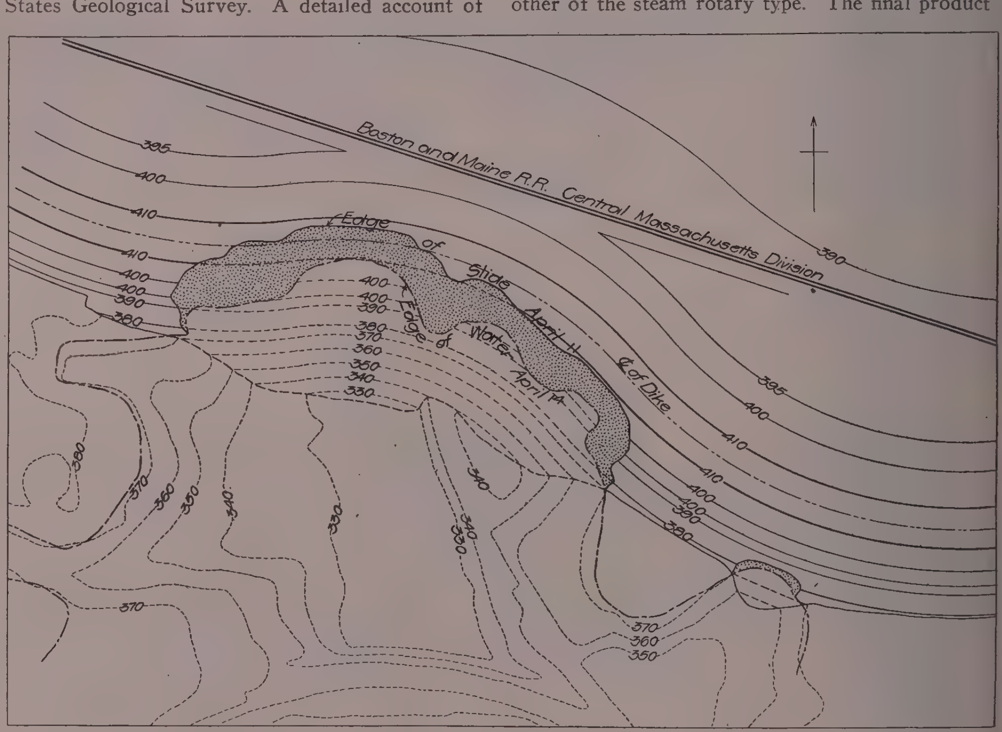
In order to enclose the basin formed by the Wachusett dam, it was necessary to build some kind of a structure across a sandy plain about 2 miles long and averaging about 15 ft. below the water level in the full reservoir. Rock lies so far below the surface of this plain that it could not be reached by a core wall. Fortunately the material overlying the rock is a very fine and nearly impervious sand, except in the upper layers, and no percolation of water through it is probable. Consequently the problem was to place on this tight bottom an equally tight embankment of some sort. The site of the reservoir was to be stripped of its surface soil. The material gathered in this way from an area of 6½ square miles had to be dumped somewhere and it was nearly as cheap to place it where the embankment was needed as at any other locality. The abundance of this material, the fact that no percolation would occur in it if the embankment were made thick enough, and the necessity of making the structure absolutely safe, led to the adoption of the novel dyke design. The possibility of using this soil for a dyke depended on its impermeability, permanence and stability, and in order to have definite information on these subjects careful investigations were made which Mr. F. P. Stearns described in detail several years ago in the "Transactions" of the American Society of Civil Engineers. The permeability of the soil was found to be only one-fourteenth as much as through fine sand, a fact which is of interest in connection with the earth slide for reasons stated later. When its organic matter was burned out it was still only about one-twelfth as permeable as very fine sand. Mr. Allen Hazen and Prof. W. O. Crosby concluded independently that the process of oxidation of its organic matter would be extremely slow, and the tightness of the dyke would not be materially affected by any changes likely to occur in the soil. The stability of the soil was found to be very great, and it was also capable of some compression, for which allowance was made in the construction.

At the place where the slide occurred, the dyke is 1,930 ft. thick at the base, 940 ft. thick at the present water level in the reservoir, and about 80 ft. high. It is at the site of a former pond, and in order that the muck and other material at this place might not be the cause of percolation a deep trench with sloping sides like a railway cut was excavated in it on the line of the dyke and then filled with the surface soil, placed in 6-in. layers and thoroughly compacted, forming a cut-off. After considerable discussion by the consulting engineers of the Metropolitan Water Board, the material from the trench, largely sand, which was mostly extremely fine, was placed in two embankments, one along each toe of the dyke. It is important to observe that this material has never been considered impermeable, like that forming the cutoff and the body of the dyke. It was given a slope of 1 on 2 on the reservoir face, and has a wide berme about

30 ft. from the top. While the construction was in progress a large amount of rock was taken out on another part of the work, and this was dumped down the slope and made into a riprap protection about 10 ft. thick, extending from an elevation 5 ft. above the high-water mark in the reservoir to an elevation 12 ft. below high-water mark. Below this the embankment was covered with 5 ft. of coarse gravel and small stones. The embankment rested directly on the natural surface of the ground, which was not very satisfactory at this place.

On April 11 a section of this embankment formed of material from the cutoff trench slid into the reservoir, apparently sliding down in several layers. The section that slipped was about 675 ft. long, and at one place was 35 ft. thick, measured at right angles to the slope. Between 60,000 and 70,000 cu. yd. of material moved in this way. None of the cutoff, which was placed in 6-in. layers and rolled, was disturbed. The momentum of the great mass of earth carried the heavy riprap to a distance of 150 to 250 ft. and some of the sand and gravel to a distance of 325 ft. from the foot of the original embankment. The water in the reservoir was about 40 ft. deep when the slide occurred. For reasons above stated, the safety of the dyke is in no way affected, and it is understood that the repairs will be started at once, the slope being made flatter than before.

A number of conjectures have been made as to the cause of the accident. It has been suggested that the material in the embankment was unsuited for the purpose when its pores were filled with water, and this condition was aggravated by the fact that during construction the sand and gravel were dumped down the slopes from the contractors' railway and may have become somewhat stratified in inclined layers, instead of compacting in a uniform mass as such material generally does. Another suggestion is that the slide was started by the weight of the heavy mass of riprap on the berme above the present water line. Still another explanation which has been advanced is that the natural bed on which the embankment rested became slippery or was compressed enough to start the motion of the material above. Whatever the true explanation may be, the incident shows the risk of using much fine sand in a permeable bank of considerable height exposed to water, even though it is faced with enough rock and gravel to hold it in place under ordinary conditions. The accident is unique in its nature and decidedly instructive, although of no importance whatever as regards the stability of the main dyke or as affecting the reliability of the dyke type.



Sketch Showing Location of Earth Slide at Wachusett Reservoir.

SEWAGE CONTAINING TRADE WASTES from works engaged in recovering ammonia from the liquors of gas plants has been successfully treated by biological methods at Oldbury, England, under the direction of Messrs. Percy F. Frankland and H. Silvester. Nine per cent. of the dry-weather sewage consists of liquors containing, in each 100,000 parts, 153.8 parts of sulphocyanides, 46.8 parts of thiosulphates, 140.1 parts of phenols, 4 parts of tar bases, and 14.2 parts of albuminoid ammonia, the oxygen consumed in 4 hr. amounting to 500 parts. An attempt was first made to treat the sewage by passing it through a septic tank and two successive bacteria beds, but the effluent was unsatisfactory, although good results were obtained when the gas liquors were kept out of the sewage. Finally an experiment was made in passing the sewage from the septic tank through three successive contact beds, which gave satisfactory results. Accordingly, experiments on a large scale following this method have been conducted without interruption for nearly two years, which have been uniformly successful.

Prevention of Stream Pollution by Distillery Refuse.

The liquid waste from distilleries is essentially a corn or rye extract and contains all the ingredients of the grain, except those removed as alcohol or carbon dioxide. This waste, which is known as slop, is disposed of in various ways, a favorite method being to feed it to cattle kept to be fattened on it. At Lynchburg, Ohio, a small town on the East Branch of Little Miami River, a distillery until recently has been discharging its waste, mixed with filth from cattle pens, into the stream and causing a nuisance as far as six miles below the town. During a period when an investigation was conducted at Lynchburg to discover feasible means of preventing pollution of streams by such waste, from 10,000 to 15,000 gal. of this refuse was discharged into the stream every day, bearing from ¾ to 1½ ton of solid material. This investigation, which was made jointly by the United States Geological Survey and the Ohio State Board of Health, was under the general direction of Mr. M. O. Leighton, chief of the Division of Hydro-Economics, United States Geological Survey. A detailed account of the work is given in a bulletin, prepared by Mr. Herman Stabler and published by the Survey, from which these notes have been taken.

Of the various methods of refuse disposal which may be adapted to the disposal of distillery wastes, evaporation seemed to be the best. In considering the use of this process the question of whether it would be more profitable to apply the process to the entire slop output or to only those liquors that cause direct pollution, presented itself. To adopt the former method involved the abandonment of the cattle feeding industry. This industry, however, is generally conceded to be financially precarious, while a detailed investigation of the process of evaporation, together with analyses of the wastes from the distillery, indicated that the sale of foodstuffs recovered from the slop would bring a substantial profit to the distillers. The final result of the investigation was the installation of an evaporation plant at Lynchburg which has been in operation over a year.

In this plant the slop passes over a series of inclined screens which separate the liquid into thick and very thin slop. The thick slop is pumped to two 40-plate filter presses, in which a great part of the solid material is taken out by compressive filtration through fine brass screens or pieces of cloth. The liquid from the presses and the thin slop from the screens passes to the evaporator.

A Hoffman-Ahlers triple-effect vacuum evaporator is used. It has three large vertical cylinders or "effects," in each of which the slop is subjected to evaporation, the concentration increasing in each cylinder. The slop passes through coils of pipe enclosed in the cylinders and is heated by steam surrounding the pipe coils. A separator is provided with each cylinder to free the concentrated liquor from vapor before it passes to the next effect.

From the evaporation process there are two products, the evaporated slop which contains not more than 75 per cent. of moisture, and the distillate which is nearly pure water and is more valuable than natural water for use in the mashing process in distilleries. The magma from evaporator is added to the moist cakes from the filter presses and passes to a screw conveyor, where the two are mixed before being dried in two driers, one operated with direct heat and the other of the steam rotary type. The final product is put in sacks and sold for stock food. The Lynchburg plant is capable of treating more than 40,000 gal. of thin slop in 20 hours and reducing it 88 to 90 per cent. in volume.

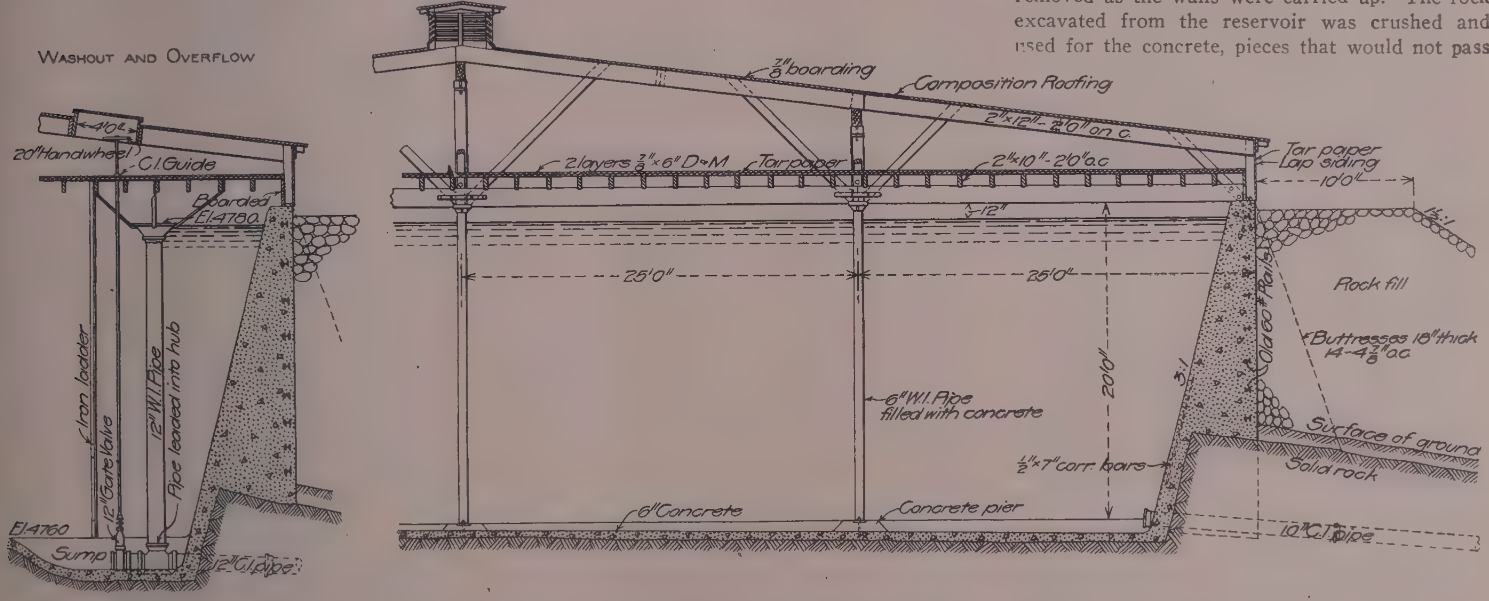
For a distillery using daily 1,750 bushels of corn for a season of 150 days and 1,392 bushels of rye for a season of 50 days, the following data regarding the process are given as approximate: Cost of complete recovery plant, $52,000; annual profit over operating expenses on investment in complete plant for evaporation recovery, 73 per cent.; cost of additional plant to add evaporation to recovery by screening, $40,000; annual profit over operating expenses afforded by increased product, based on investment in additional plant to add evaporation to recovery by screening, 34 per cent.

AN ERRATUM should be made in the article printed last week on the new power plant of Walter Baker & Co., Ltd., at Dorchester, Mass. It was stated in the article that a Green fuel economizer was used, whereas, as a matter of fact, this was not the case for the economizer in the plant was built and erected complete by the economizer department of the B. F. Sturtevant Co.

The Water Supply of the Oregon Short Line at Pocatello, Idaho.

A somewhat extensive water supply system is included in the recent improvements that have been made by the Oregon Short Line R. R. at Pocatello, Idaho. This system supplies the division shops at this point, and also furnishes water for general railroad use. The water is obtained from a series of springs, known as the Batise Springs, which are on the bank of the Portneuf River, 5.4 miles west of Pocatello, and about one-half mile from the main line of the Oregon Short Line R. R. These springs have a flow of approximately 2,000,000 gal. per day, the water being of excellent quality for both boiler and drinking purposes.

The water is pumped to the Pocatello yards through a 10-in. pipe line, built of extra heavy cast-iron pipe, tested to 300 lb. per square inch. This pipe line is connected with a 2,000,000-gal. regulating reservoir at a point about one mile from the springs, by means of a branch line of the same diameter as the main line. This reservoir is 1,600 ft. off the main line, the branch connecting it with the main line being of that length. The top of the reservoir is approximately 265 ft. above the Pocatello yards and 350 ft. above the springs, and affords a static pressure of 115 lb. per square inch at the yards.



Details of Reservoir of the Oregon Short Line Railroad at Pocatello.

The pumping station is on the west side of the springs, the east wall of the pump house forming one side of a basin from which the water is drawn. The pump house is a brick building 37 ft. x 51 ft., which is divided transversely into a boiler room and a pump room of equal size. The building is of fireproof construction with a concrete floor and corrugated iron roof carried directly on 8-in. channel purlins.

A trestle extends along the west side of the pump house and is connected by a spur with the main line of the railroad. A coal bin is placed under this trestle and the coal is dumped directly from the cars into the bin, the latter being connected with the firing floor in the boiler room by lifting steel doors making a convenient plant for handling coal.

The boiler plant consists of a battery of two 75-h.-p. Geary water-tube boilers of the horizontal tube type, which are designed for 125-lb. working pressure.

At present a single pumping engine is used to force the water through the pipe line and into the reservoir, but space is provided in the pump house for another unit of the same size, as it is likely in the near future the single pump will not be sufficient for the demands of the railroad. A 14 x 26 x 7¾ x 18-in. cross-compound condensing Meyer-gear pumping engine, built by the Laidlaw-Dunn-Gordon Co., of Cincinnati, has been installed. The rated capacity of this pump is 834 gal. per minute, against a head of 400 ft. with steam at 125 lb. pressure. A duty of 90,000,000 ft. lb. per 1,000 lb. of steam was also guaranteed by the makers. The steam receiver between the high and low-pressure cylinders is of the superheating type.

A Knowles surface condenser having 225 sq. ft. of condensing surface is attached to the pumping engine, the discharge from the air pump being delivered directly to the hot well. The suction of the main pump is drawn directly through ft. of condensing surface is attached to the pumping engine foundation rest upon solid rock, which lies close to the surface in the vicinity of the springs. The pumping engine draws the water from a small sump in the pump room, which is connected directly with the basin enclosing the springs by an opening in the concrete wall of the pump house.

The basin in which the principal springs are situated is 40x52 ft. in plan. It is enclosed on two sides by a loose rock wall, the pump house footing forming a third side, while the fourth side is left open to allow any excess of water to escape through its natural channel. The basin is covered by a light batten roof, carried on two wooden trusses, for the purpose of excluding dirt and also to prevent the growth of aquatic plants.

The pumping plant was built directly by the railroad company forces, the total cost being $21,500, including all machinery and equipment.

The reservoir is on the side of a low mountain range which bounds the valley on the south. The only available reservoir sites in this vicinity are on steep slopes, composed of solid lava rock, and as the site chosen was no exception the reservoir construction was quite expensive. The reservoir is 100x160 ft. in plan at the top, and 20 ft. deep, the slope of the walls on the inside being 1 on 4. It is almost entirely in cut at the upper side, while at the lower side the cut is from 2 ft. to 6 ft. The lava rock in which the excavation was made is badly seamed, which renders it very permeable and necessitated the reservoir being lined throughout. The bottom is lined with concrete of a minimum thickness of 6 in., the mixture being 1:3:5, with a 1-in. top coating of 1:1½ mortar. The sides of the excavation are lined with 12 in. of concrete. Above the excavation the sides of the reservoir are formed by concrete retaining walls, backed by a loose rock fill. These walls are 18 in. thick at the top, the outer face being vertical; the inner face has a batter of 3 in. to the foot and is a continuation of the face of the lining of the sides of the excavation. Buttresses 18 in. thick are built against the outer side of the walls, about 14 ft. apart on centers, and are carried down to the natural rock surface around the reservoir, the back having a batter of 4 in. to the foot.

The walls are reinforced near the outer face with old 60-lb. rails, laid horizontally 2 ft. 6 in. apart. At the junction of the retaining walls and the 12-in. lining ½-in. corrugated bars 7 ft. long are placed vertically 12 in. apart on centers and 3 in. from the face of the walls, to prevent cracking between the latter and the lining. The rock fill backing of the retaining walls is 10 ft. wide on top and is carried down to the natural surface on a 1½ on 1 slope. The excavation for the reservoir was made in such a manner that concrete was all placed on undisturbed foundations, such voids as occurred outside of the lines of the excavation being filled with 1:4:8 concrete.

The inner surface of the reservoir walls is finished with a 1:1½ mortar facing, 1½ in. thick, the mortar being deposited between the wall forms and thin portable forms, the latter being removed as the walls were carried up. The rock excavated from the reservoir was crushed and used for the concrete, pieces that would not pass a 2½-in. ring being excluded. The concrete was made in a mixer, and was generally mixed fairly wet. The construction of the reservoir was very successful, no leakage being detected after the reservoir was filled.

The reservoir has a double covering, consisting of a flat floor laid just above the top of the concrete walls and a double pitch roof 10 ft. 3 in. above the walls at the ridge and 4 ft. above them at the sides, the object of the double covering being to prevent freezing in the severe climate in which the reservoir is located, and to exclude dirt. This covering is carried by the side walls and by three rows of columns, spaced 25 ft. apart transversely by 22 ft. 10 in. longitudinally of the reservoir. These columns are of 6-in. steel pipes with cast-iron base plates and caps. After being set in place the columns were filled with concrete to prevent rusting.

The floor over the reservoir consists of two layers of ⅞x6-in. flooring, with tarred paper between the layers. The pitched roof is composed of ⅞x6-in. matched boarding, on 2x12-in. rafters, covered with prepared roofing. Ventilation is secured by means of two 4x8-ft. monitors placed at the ridge of the roof, and through openings in the floor, which are 2 ft. square, and are spaced 16 ft. apart around the sides of the reservoir.

The 10-in. branch from the main pipe line forms the inlet and outlet of the reservoir and extends through the wall on the downhill side of the latter, 6 in. above the bottom. The bottom of the reservoir is sloped to a sump at the middle of the downhill side, the sump being connected with a 12-in. washout pipe. A 12-in. overflow pipe inside of the reservoir, with its top 12 in. below the top of the reservoir, is connected with this washout pipe.

The excavation and concrete work on the reservoir was done by contract, the covering being built by the railroad company. The contract prices for excavating and grading for the reservoir are about the same, including the placing of excavated material outside the reservoir walls, back-filling against walls, and completing the embankments formed of the excavated materials was as follows: Earth, 30 cents per cubic yard; loose rock, 70 cents per cubic yard, and solid rock, $1.50 per cubic yard.

The three classes into which the excavation was divided were classified as follows: Solid rock was considered to consist of rock in place which could only be removed by blasting and all detached masses or boulders containing more than 1 cu. yd. Loose rock consisted of rock in place, whatever its character, which could be removed without blasting, or detached masses of boulders exceeding 2 cu. ft., but less than 1 cu. yd. of material; also all shale, soft sandstone, soapstone and material of that nature that could be quarried or removed without blasting, and such hardpan, gravel and boulder deposits that could not be picked or loosened with ordinary picks, well sharpened and well handled. The use of powder was not considered conclusive as to its necessity.

The contract price for concrete, including the necessary material for forms and the placing of the latter, was $6.50 per cu. yd., the cement and sand being furnished on cars near the work by the railroad company. The total cost of the reservoir at these prices and including the work done by the company was $32,000. The railroad company furnished free transportation over its own tracks to the contractor for all material, tools, supplies, and men necessary to execute the contract.

The pipe line is all of 10-in. hub and spigot cast-iron pipe, laid in the ordinary manner, with the joints caulked with oakum and lead, the pipe being covered to a minimum depth of 4 ft. For the greater part the pipe line follows the right of way of the railroad. A considerable amount of the trench work was in lava rock, making the cost high. The pipe was purchased and delivered by the railroad company, but was all laid by contract. The following contract prices were paid for the construction of the line: For excavating the trench: Earth, 60 cents per cubic yard; loose rock, $1.50 per cubic yard, and solid rock, $3 per cubic yard. For handling, placing and caulking the pipe and completing the pipe line ready for service, 22½ cents per linear foot of pipe line. For back-filling, 10 cents per cubic yard. At these prices the total cost of the pipe line was $52,000.

The water supply system was completed July 1, 1906, and has given satisfactory and continuous service since then. The work was done under the general direction of Mr. Wm. Ashton, chief engineer, and Mr. J. P. Congdon, supervising engineer, and under the direct supervision of Messrs. H. H. Fielder and C. P. A. Lonergan, assistant engineers of the Oregon Short Line R. R. The contract for the pipe line and reservoir was awarded to the Utah Construction Co., of Ogden, Utah, and was sub-let to the Corey Bros. Construction Co., of the same city.

AN EXPERIMENTAL ELECTRIC SMELTING PLANT of 50 tons capacity is now being built about 6 miles from Kermit, Cal., by the Northern California Power Co., for smelting iron ore.

Waterways in Great Britain.

The appointment by President Roosevelt of a commission to investigate the inland waterways of this country, and related problems, draws attention to the fact that a somewhat similar commission has been studying similar subjects in Great Britain for a year or more. Railway rates have not been wholly satisfactory there and a feeling developed that it was desirable to know more about the facilities which an improved network of canals would afford, for the satisfactory results of improved canals and canalized rivers in Germany, Belgium and France are well known. The subject has both commercial and engineering sides, and the former are the more important, just as in the United States. As Sir E. Leader Williams pointed out clearly a couple of years ago, it is unreasonable to expect that county and local authorities will pay for canals traversing their territory merely to enable inland manufacturers to get their materials from and to the seaports; a broad, general view of the subject must be taken, which makes it one for financiers and the nation. The general subject of British waterways is consequently not unlike that of American waterways, and attention is accordingly called to an important paper and discussion "On Waterways in Great Britain," which takes up nearly 150 pages of Volume 163 of the "Proceedings" of the Institution of Civil Engineers. The paper was by Mr. John A. Saner and its discussion is particularly valuable because of the frank comments on canal transportation by representatives of railways. It is impracticable in the restricted space of a technical journal to give a complete review of the subject as presented in the Institute's publication, and the following notes only to a few of the aspects which were discussed.

The Aire and Calder Canal was stated by Mr. Saner to be the leading waterway of the kingdom, its success being due mainly to the energy of Mr. W. H. Bartholomew, for many years engineer and general manager and now director, under whose advice continual improvement has been made to meet the altering circumstances of trade, and whose method of conveying coal in bulk by means of trains of "compartment" boats is probably the cheapest method of carriage known. These divisible trains, consisting of 37-ton boxes, can be loaded at the pit mouth, and after being towed to Goole, twenty or twenty-five at a time, they are lifted by hydraulic machinery and tipped direct into the holds of seagoing vessels. The locks are now about 212 ft. long by 22 ft. broad, with 9 ft. of water on the sills, and it is proposed to increase them to 460 ft. by 22 ft. by 9 ft. Further, a new canal, about 5½ miles long, has been constructed recently, connecting the Don Navigation with the Goole and Knottingley Canal portion of the Aire and Calder Navigation. The lock on this length is 215 ft. by 22 ft. by 9½ ft. in normal depth.

The next navigation in order of merit is considered by Mr. Saner to be the Weaver Navigation, of which he has long been chief engineer. It is inferior to the Aire and Calder only in being shorter, and therefore not capable of earning so large a revenue. In the matter of works and equipment, however, it probably ought to be placed first. The long lengths of natural river in the Aire and Calder Navigation give it an advantage, owing to the fewer artificial works needed per mile of navigation, whereas the Weaver is practically artificial for its whole length of 20 miles. But although so short, and until recently practically dependent on the salt industry and the allied alkali industry, it has been, and is, a sound paying concern. The river is now navigable for steam barges of up to 450 or 500 tons burden, but the ordinary steam barge has a carrying capacity of 200 to 250 tons, and tows three dumb barges of like dimensions. The locks are capable of passing such a train of 1,000 tons at once, and these trains, being self-contained, can be brought alongside a ship at Liverpool, and there discharged by means of the long derrick masts which are provided on all the steamers. These derricks also enable goods to be landed, if required, at any point on the banks, without special wharves being constructed.

Since the construction of the Anderton lift in 1875, connecting the Weaver with the Trent and Mersey Canal near Northwich, a large carrying trade has been developed with the Midlands, it being found possible to compete with the railways, even with the handicap of a transhipment. Goods are brought up the river from Liverpool in the steam barges, but have to be transhipped at Anderton into 25-ton narrow boats in order to pass up the canal to the Potteries. The trustees have received parliamentary sanction to raise further money for enabling them to increase the capacity of the Anderton lift, the hydraulic rams of which show signs of serious decay. The Weaver Navigation terminates at Weston Point in a small dock system. Formerly, the entrance was direct from the River Mersey, but since the construction of the Manchester Ship Canal a large portion of the Weaver traffic passes through that canal to Eastham.

A third important waterway which has received attention in recent years is the Severn. Considerable improvements have been made, under the guidance of the late H. J. Marten, and vessels of nearly 10 ft. draught can now navigate as far as Diglis, near Worcester, where dock accommodation has been provided. But the whole of the improvement is at present stultified by the existence of some low-level bridges near Gloucester, and until these are removed the navigation can be used only by barges.

The upper reaches of the Thames have been improved by the erection of the Richmond lock and sluices, and several of the locks have been rebuilt in order to make them more convenient; but the most important use at present made of this river is as a pleasure resort for the inhabitants of London and Oxford. It appears to Mr. Saner that, were this waterway systematically deepened, it would form a valuable highway for agricultural produce forwarded to the London market.

With regard to canals proper, improvements have been made recently on the Grand Junction Canal, where several of the locks have been improved, and where an inclined lift for overcoming a 70-ft. change of level near Market Harborough has been erected under the advice of Mr. Gordon C. Thomas. This lift is a work of considerable magnitude and ingenuity; it admits of the ordinary 70-ton barges being raised or lowered as required, and, like the Anderton lift on the Weaver, saves considerable time and labor. The utility of this canal as a route between London and Birmingham is greatly diminished by its being connected with the narrow-gauge Oxford Canal, and there is therefore no through route for any but the smallest boat.

On the Leeds and Liverpool Canal lengthening of the locks has been carried out between Liverpool and Wigan, and further improvements are contemplated. The lengthened locks, however, only admit vessels not exceeding 72 ft. by 14 ft. 4 in. and the draught for through traffic is limited to 3 ft. 3 in.

The Scotch canals were all built for interoceanic trade, but they are now too small for that purpose. The Forth and Clyde Canal earned in 1898 a net revenue of more than £20,000, and, although this is less than 2 per cent. of the capital invested, it certainly points to the fact that a ship canal of reasonable dimensions is required in this part of the country, for commercial as well as for strategic reasons.

To Mr. Saner the present condition of the canals appears to be due to three main causes: (*a*) Want of uniformity of gauge; (*b*) want of co-ordination and centralized management; (*c*) the action of Parliament, and in some cases of the canal companies themselves, in allowing railway companies to buy the connecting links of through routes.

The second cause, want of co-ordination in management, illustrates the exceedingly conservative conditions under which business is carried on in England. Instead of amalgamating and grouping canals in the same way as railways are now grouped, each little bit of canal has its own staff. Consequently there can be no economy; maximum charges go with minimum efficiency; the majority of the positions do not attract good men; and, so far as the higher officials are concerned, the canal may be an almost forgotten part of a private practice. If amalgamation of canals and rivers within reasonable areas took place, good men would be induced to look after them, and the repairing and clerical staffs would not only be more economically employed, but would also consist of better trained and more experienced persons.

With regard to the third cause, it is, of course, too late to compel the railway companies to give up without adequate recompense the portions of canal under their control, to either trusts or companies which they would certainly look upon as competitors. It must be assumed that the railway companies do not consider it possible to make successful commercial use of their canals in conjunction with their lines, otherwise, as business men, they would have done so.

That a combined system could be economical, Mr. Saner has no doubt, and it surprises him to see that those companies owning both railway and canal have not developed the latter, instead of spending money in doubling their tracks. For instance, the London and North Western Railway Company control the Shropshire Union Canals, and were they to improve the main line of that system of canals betwen Ellesmere Port and Wolverhampton they would be able to deliver coal at Liverpool in competition with Lancashire, and without increasing the traffic on their already overburdened railway. The time of delivery by water is really not much longer than by goods train; a heavy consignment from, say, London is seldom delivered in Cheshire under three days by rail, and the same time suffices for delivery by even the present canals.

According to the Board of Trade Returns for 1898, there are 2,768 miles of "free" canals (i. e., canals independent of railways), conveying 33,348,573 tons of traffic per annum, with a net profit of £216 per mile of navigation; while there are 1,138 miles owned by railway companies, which convey only 6,009,820 tons per annum, and produce a net profit of only £40 per mile of navigation. This appears to afford clear proof that the railways do not attempt to make the most of the canals under their control. The returns also show on further investigation that, even with the small canals now in use, the canal companies can earn dividends.

If the different canals and navigations are compared, the profit yielded by those under progressive management, such as the Aire and Calder, the Weaver and the Leeds and Liverpool Canals, is found to be 3 to 5 per cent. on the outstanding debts, the highest being, it is believed, the Weaver, where, however, the undertakers only take toll, and do not themselves act as carriers. On the other hand, the Weaver is handicapped with a short mileage, as a set-off to its having a larger sectional area, and giving better facilities than any other inland navigation in the Kingdom.

The great benefit of waterways is not their dividend-earning power, but the facilities they afford for traffic, and the consequent gain to the country as a whole. It surely ought to be recognized by now that cheap transport is of far more importance to the country than are large dividends to comparatively few shareholders, whether they hold railway shares or canal shares. No better instance of the beneficial results of carriage by water can be adduced than those experienced by Manchester from the Ship Canal, which, even though it has had to be partially supported by the city rates—and in this respect follows closely the example of continental countries, where all canals are practically free and supported by the State—has increased the traffic and improved the value of the city to a very large extent. In place of partially deserted streets, which Mr. Saner remembers seeing 20 years ago, there is now a heavy traffic, all, or nearly all, of which is due to the canal; in fact, during this period a large portion of Manchester has been rebuilt and remodeled. The case of Manchester, however, is different from that of many other places; the city has become a port; and as it is neither physically nor commercially possible to equip all inland towns on the same magnificent scale, it is a matter for consideration to what extent it is possible to connect them with the ports and with each other by means of improved waterways.

In the first place canals not only connect the principal towns, but also cover the whole of the industrial center of England. Some, however, are owned by railway companies, and, except in one or two cases, these sever all the main routes. Except for the smallest class of boat, it is impossible to use a through route. For instance, going from Hull to Birmingham large boats can navigate as far as Gainsborough only, and shallow-draught "dukers" from Gainsborough to Burton; the remainder is only suitable for narrow boats. Traveling from Liverpool to Birmingham 300-ton boats can get as far as Anderton on the Weaver, and 70-ton boats as far as Middlewich, but after that, all through the Potteries, only the smallest 20-ton narrow boats can navigate. So throughout there is chaos instead of uniformity, each little bit of canal charging its maximum toll and giving minimum facilities. How would the railways have fared if there had been a change of gauge every few miles?

In the discussion of the paper, Sir E. Leader Williams observed that continental countries had opened canals connecting their manufactories with the sea; thus raw materials were brought in by the canals, and manufactured goods were taken out, at rates which were very low compared with the charges in England. In many cases the work had been carried out by the State, not out of local contributions, but with the aid of public funds—in the same way as the great Holyhead road, with the beautiful Menai bridge, had been made, in order to develop trade with Ireland. It was often said that the railway companies ought not to have bought the canals; but they could hardly be blamed for desiring to buy out their competitors. On the other hand, it was a grave question whether Parliament, representing the interests of the whole country, should have allowed this to be done. Instead of increasing their capital accounts so largely—without, however, increasing their dividends—the railways might have done the country a valuable service, and benefited themselves at the same time, by developing their canals. The permanent way of railways had little claim to the title "permanent." The more traffic was put on the rails, the sooner were fresh rails required; and comparison of the weight of the rails put down in his younger days with the weight of the rails put down at the present time showed one reason for the increased expenditure. The only real permanent way was a waterway. The canal question was one not of engineering alone, but also of finance. He believed a great deal might be done, not in the direction of improving canals in merely agricultural districts—because the present canals were quite good enough to carry farm produce—but in improving canals uniting the great manufacturing districts with the coast.

As general manager as well as engineer he had seen something of the difficulties of canal working, and he had found that it was not possible to compete with railways while the boats were being tied up at a public house every 10 or 12 miles, in order, as the bargees put it, "to give the horse some water." Consigners declined to continue to send goods by canal when they were sometimes in time for the ship and sometimes not. He had therefore made up his mind to introduce a system of traction which would enable him to compete with the railways, and he had had a small portable locomotive boiler and a couple of cylinders put into a boat, the machinery being such that it could be taken out with a heavy crane when repairs were required. He started with half a dozen tugs, and he believed there were now twenty. They could tow three or four 50-ton barges with ease at 3 to 4 miles per hour—quite sufficient speed without damaging the canal banks. The captain of the tub received a bonus if he kept to time, so that he took good care the boats did not stop at the public houses; and, by working all night, competition with the railways could be maintained. On the Weaver Navigation a large steamer, carrying herself a cargo of 200 to 300 tons, towed three boats, and the train of vessels passed through the large locks together. Nearly the whole of the salt went from Cheshire district to Liverpool by water. There could be no question whatever but that water afforded the cheapest means of conveyance; the main question was how to find the means to carry out the work of improving the canals.

Mr. G. R. Jebb pointed out in the discussion that the author's statements as to the stagnation of railway-owned canals, and the neglect to improve them, were not applicable to the two systems of canals of which he had been the engineer for many years, namely, the Shropshire Union Canals, extending over 200 miles, and the Birmingham Canals, extending over about 170 miles, both of which were partly controlled by the London & North Western Railway Co. On both of those canals considerable improvements had been made, and large sums of money had been spent in providing additional facilities for traffic. Among other things, many miles of waterway walls had been built. At Ellesmere Port, where the Shropshire Union Canals joined the Manchester Ship Canal, several hundred thousand pounds had been spent during the last few years in development; deep-water quay walls of considerable length had been built, and the depth of water varied between 20 feet and 24 feet at the lowest state of the tide. A large grain warehouse, fully equipped with grain elevators and other appliances, had been built at a cost of nearly £80,000, and there was also an excellent system of hydraulic cranes. At the present time the dock area was being enlarged, chiefly for the purpose of accommodating deeper barges, drawing about 7 ft. The Shropshire Union Canal Company were large carriers to and from the large towns of the Potteries, although the waterway there, the Trent and Mersey Canal, did not belong to them. In each of those towns very heavy outlay had been made on building warehouses for pottery materials, and these facilities had afforded great encouragement to canal traffic. During the last 25 to 30 years the capacity of the reservoirs on both the canals had been largely increased, and within the last few weeks he had arranged for two additional new sources of water supply at very considerable cost.

A Large Four-Ply Belt, recently made by the Providence Belting Co. for the Narragansett Electric Lighting Co., Providence, R. I., is 78 in. wide, 140 ft. long, and weighs over 3,000 lb.

The Warehouse Point Bridge of the New Haven R. R.

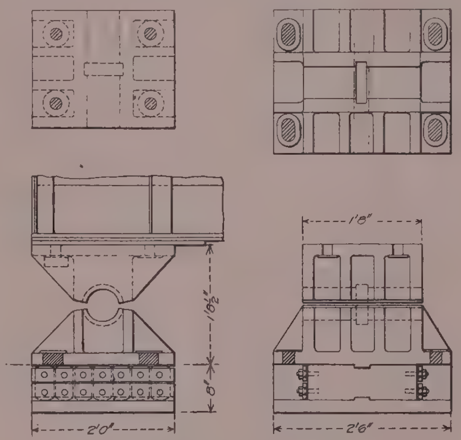
The long double-track deck plate girder bridge of the New York, New Haven & Hartford R. R. across the Connecticut River at Warehouse Point, which has recently been completed, is interesting both as an example of plate girder construction for heavy traffic at high speed, and because of the interesting history of the bridge previously occupying the same site, which was long famous as one of the earliest iron bridges in this country, and because it was fabricated in England at the close of the Civil War.

The first railroad structure at this point was a single-track Howe truss bridge, 1,524½ ft. long, which was completed in 1844 for the Springfield, Hartford & New Haven R. R. Co., whose line then extended from New Haven to Springfield, forming an independent link in the route between Boston and New York. The structure included seven 177-ft. deck spans, carrying the track at a height of about 46 ft. above water level. After being in service about two years, it was destroyed by a gale which blew it bodily from its piers into the river, but was replaced with a delay of only 45 days by similar spans, which lasted nearly twenty years until replaced by the famous iron structure.

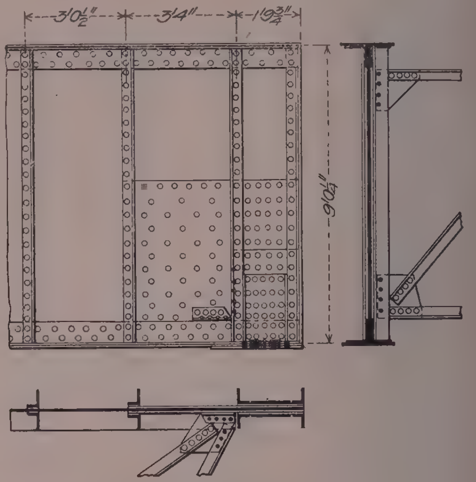
The iron bridge was designed by Mr. James Laurie, the first president of the American Society of Civil Engineers. It was a double-track deck structure including twelve 88½-ft. spans and one 177-ft. channel span. The riveted trusses were divided into short panels by vertical posts, intersected by two or by three diagonals according to the depth of the truss. Both top and bottom chords had trough-shaped cross-sections made of plates and angles fastened together with 1-in. rivets. It was at first intended to provide iron floorbeams, but on account of their great cost, they were not used and 7x12-in. wooden floorbeams 17 ft. 9 in. long, and 20 in. apart on centers were employed, which carried the 9x15-in. track stringers. At each end of the main structure there was a short deck plate girder span and at one end there was also a 140-ft. through truss span across a canal on that side of the river. The total iron work weighed about 624 tons, and several important firms in New York and Pennsylvania were invited to bid on it, but failed to receive the contract because they could not complete the work as quickly or as cheaply as it could be done abroad. The contract was therefore finally divided between Wm. Fairbairn & Co., Manchester, and the London Engineering & Iron Ship Building Co., London. The bridge was designed for a live load of one ton per linear foot, and the dead load of the longest span was calculated at 1½ tons per linear foot. The material used had an ultimate tensile strength of about 48,000 lb. per square inch, and the maximum unit working stresses were 10,000 lb. in tension, and 8,000 lb. in compression.

As the new spans were only half as long as the old ones, new masonry piers were built intermediate between the old ones, and with them supported the superstructure, which was erected without interruption to traffic on the old bridge. For the regular spans the new trusses were erected between the old ones under the existing railroad floor and were supported on longitudinal timbers carried by transverse timbers on the bottom chords of the old trusses. This necessitated placing the trusses 8 ft. 9 in. apart on centers, a very narrow width for the length of span. The old bridge was crossed by about 26 trains daily, and in the intervals between them the new iron work was brought out on the track and lowered into position between the old trusses. The lower chord plates were first placed separately in position, assembled and riveted up, after which the vertical posts were assembled to them, then the top chord web plates, angles and horizontal cover plates were successively assembled and riveted together. The bridge contained about 175,000 rivets, one-half of which were field driven, at the rate of 40 to 240 a day by five men gangs. The shop rivets were driven at the rate of about 1,500 daily.

As fast as each span was completed it was subjected to a test load by a train weighing one ton per lineal foot. Erection was commenced in June, 1865, and was finished in the following February. It was considered at that time that unusual skill and courage were displayed in the successful execution of the work, and that the great height and length of the bridge, the maintenance of traffic, the depth and velocity of the water, involved unusually great difficulties which were successfully surmounted. The bridge was stated to be one of the best in the country and capable of lasting, with proper care, for a century. The cost of the iron work in London was $85.58 per ton in gold, an amount which was more than doubled by the premium on gold, expenses of shipment, etc. The erection cost nearly $17,000, and the final cost of the superstructure was $173,109.52, equal to 12.38 cents per pound. An interesting illustrated description of the bridge was prepared in 1866 by Mr. C. G. Ellis, from which the above notes are taken through the courtesy of Mr. Clemens Herschel.



Expansion End Bearing.



Reinforced Girder End.

The New Bridge over the Connecticut River at Warehouse Point.

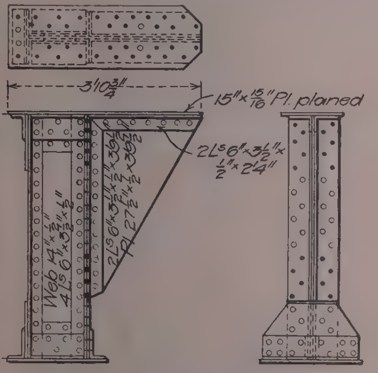
The present bridge has a total length of about 1,470 ft, and was built according to the specifications of the New York, New Haven & Hartford R. R. Co. It carries two tracks across the river at a height of about 40 ft. above water. It has two masonry abutments and sixteen piers, all of which are skewed about 9 in 19½ with the axis of the bridge. The superstructure includes one 135-ft. through riveted truss span, one 177-ft. through pin-connected truss span, one 76½-ft., one 43½-ft., twelve 83½-ft. and one 22½-ft. deck plate girder spans. The lengths of these spans are here given approximately center to center of piers. There are four lines of plate girders spaced respectively 3 ft. 3 in. and 9 ft. 9 in. from the axis of the bridge. All of them, except the two shortest spans, have pin-bearing supports and are provided with expansion shoes at one end. In each span the girders for one track are braced together in the usual way with transverse frames and top and bottom X-bracing, and those for the separate tracks are independent of each other, except for transverse bracing at their extremities.

In the long spans, the girders are 88 ft. long over all, and 9 ft. deep from back to back of flange angles. The webs are made of plates from 11 to 12½ ft. long and vary in thickness from ⅜ in. at the center of the span to ½ in. at the ends, where they are reinforced by pairs of ⅜-in. plates about 5½ ft. wide, which extend from the lower half way to the top flanges. All web splices are uniform and are made with four vertical rows of shop-driven rivets through a pair of 14x7/16-in. cover plates about 7 ft. 8 in. long, which terminate at the flange angles. The web is divided into panels, most of them 3 ft. 1¼ in. long, by pairs of 6x3½x⅜-in. vertical stiffener angles and fillers.

An extra pair of web-stiffener angles is placed about 22 in. from each end of the girder to take care of the shear over the abutment, and the narrow panels between them and the end angles are reinforced, to a total thickness of 2⅞ in., by additional cover plates extending part way from the bottom flange to the tops of the wide ⅜-in. cover plates already mentioned. The flanges are pairs of full-length 8x8x11/16-in. angles reinforced by four 20x9/16-in. cover plates, 88 ft., 67½ ft., 56 ft. and 42 ft. in length, respectively.

The intermediate sway frames are of the usual type, with X-braces and transverse top and bottom angles riveted to the vertical web stiffeners. The end sway brace frames differ from them in that there is only a single diagonal member, which, like both top and bottom transverse members, is a pair of angles riveted to connection plates engaging the flanges of the end and of the adjacent vertical web-stiffeners of the girders. Owing to the skew, the sway brace frames do not engage corresponding points of opposite girders, and those at the ends engage one girder of each adjacent span. Both top and bottom lateral systems are made of X-brace angles having their horizontal connection plates riveted, not to the bottom and top flanges of the girders, but to connection angles on the girder webs. The connection plates are also field riveted to the transverse truss and are notched to clear the vertical web-stiffeners.

At each end of each girder a 20x24-in. cast shoe with 2-in. base plate is secured to the bottom flange by four 1¾-in. bolts. It receives a 5½-in. pin 20 in. long with a half-hole continuous bearing, reinforced by longitudinal webs. A corresponding casting serves as a pedestal and is like the shoe reversed, except that the width of the base is increased to 30 in., providing for anchor-bolts outside the outer longitudinal webs, which in this case are braced by transverse webs. The fixed end pedestal has 2⅛-in. round cored holes for the anchor bolt and is seated directly on top of the pier. At the expansion ends, the anchor-bolt holes are slotted 2⅛ x 3⅜ in., and the bottom of the base plate is planed, with a longitudinal center guide rib to engage the rockers. The latter are a group of segmental medium open hearth steel rollers, 6 in. in diameter, with two ¾-in. stud bolts in each end to connect them with upper and lower spacing strips. The sides of the rockers are planed vertical, and set with a clearance of ¼ in. between them so as to limit sharply the amount of deflection which they can assume.



Riveted Support for Girder.

The 76½-ft. span is similar to the 88-ft. spans, except that its web is only 8 ft. deep and the materials are somewhat lighter than in the longer span. The girders for the 43½-ft. span are about 5½ ft. deep and are made of pairs of 6x6x11/16-in. flange angles and 15x9/16-in. flange cover plates. Reinforcement is omitted at the ends of the webs, and the latter are divided into panels of 1½ to 4 ft. in length. The top flanges of all girders are in the same horizontal plane, and as the girders of this span are so much shallower than those of the adjacent long spans, it was impracticable to support them uniformly on cast pedestals and shoes, and vertical knee-braced columns were substituted for them. These were field-riveted to the bottom flanges at both ends of the girders and thus gave fixed supports for them. Similar vertical post supports are provided for the river end of the 22½-ft. girders, which have 30x⅝-in. web plates and pairs of 6x6x11/16-in. flange angles, reinforced by single full-length 15x9/16-in. cover plates. The bridge was erected by the American Bridge Co., and fabricated at its Pencoyd plant.

Oyster Shell Roads.

Oyster shell roads have been in use in Salem County, N. J., for about thirty years and have proved reasonably satisfactory, even though usually built by simply placing the shells on the road to be compacted by traffic. The time has come when, according to Mr. Josiah Miller, county engineer, the cost of this material makes it necessary for the road builder to use only those methods of construction which will give the best results.

Shells possess the power of cementation to a very great degree, and in this lies their chief value as a road material. They are not hard and will not stand much wear, but when cemented together they present a smooth, firm surface, and will then give an extraordinary amount of wear, though the softness of the material would lead to their condemnation by one who was ignorant of their other good qualities.

Dampness will cause shells to become soft and useless for road purposes in a short time. Some shells taken from the abutment of a bridge, where they had been used as filling in the days when shells were to be had almost for the asking, had been subjected to the ebb and flow of the tides for many years. When taken out they were, to the eye, in almost the same condition as when placed there. The laborers usually use forks in handling shells, but in this case they were obliged to resort to shovels because the forks pierced the shells so easily. These shells were placed on the approach to the bridge, and in less than a year the road at that point was in almost the same condition as before. The shells were soft and had also lost all the cementing qualities they possessed, and practically disappeared in that length of time.

The practice of allowing travel to consolidate a shell road is not, in Mr. Miller's opinion, either economical or efficient. It saves the expense of rolling, but whether this offsets the ill effects of the method is doubtful. Rolling will consolidate the shells at once in the place in which it is intended they shall remain, and, if the roller is properly proportioned in weight, will bring them to a compact mass with a minimum amount of breakage. Consolidation by travel spreads the material during the operation, and the wheels form ruts which crush the shells almost to the bottom of the bed and certainly drive some of them into the sub-grade when possible, and when the sub-grade is an old road, as is often the case, will surely crush the material out of all semblance to an oyster shell. It is then necessary to fill up these ruts by raking in from the edge of the bed or by using new material which then receives the same treatment. This makes a road bed of fine material entirely, whereas a roller will grind the surface of the road into a condition that will enable the cementing qualities of the shells to act and leave the lower or bottom portion of the bed to be ground up and cement itself as needed.

Mr. Miller does not believe that automobiles injure a shell road as much as they do a macadam road, because of the finer texture of the former, which makes it less likely to be affected by the suction of the rubber tires. The dust nuisance is about as serious on one road as the other.

New York City had a population of 4,113,000 in 1906, according to a report just issued by the Director of the Census; in 1900 it was 3,437,000. The estimated population of the country, exclusive of Alaska and insular territories, was 83,942,000 in 1906. Chicago had 2,049,000 people, Philadelphia 1,442,000, St. Louis 649,000, Boston 602,000 and Baltimore 554,000. The urban population of the country increased 15.9 per cent. in six years, while the population of places under 8,000 increased but 8.8 per cent.

The Sewage Disposal Plant of the Soldiers' Home, Johnson City, Tenn.

The sewage disposal plant at the Mountain Branch of the National Home for Disabled Volunteer Soldiers at Johnson City, Tenn., comprises a septic tank, four contact beds and four sand filters. When the plant was designed the number of occupants of the Home was about 1,200, but accommodations are available for nearly 3,000. The plant is therefore designed to operate under a wide variation of sewage flow, its estimated maximum capacity being 300,000 gal. per 24 hours. The sewage from the Home is entirely domestic in character. The effluent from the sand filters and the sludge from the septic tank are discharged into Brush Creek, which is a torrent at times during the spring and fall, although small for a great part of the year. As the stream already receives the discharge from many private sewers and drains in Johnson City and the refuse from a tannery, it is more or less polluted. The government authorities, however, did not wish to turn the sewage from the Home into this creek without first securing the highest practicable degree of purification. That the disposal plant effluent is of a better quality than the waters of the creek is visibly apparent.

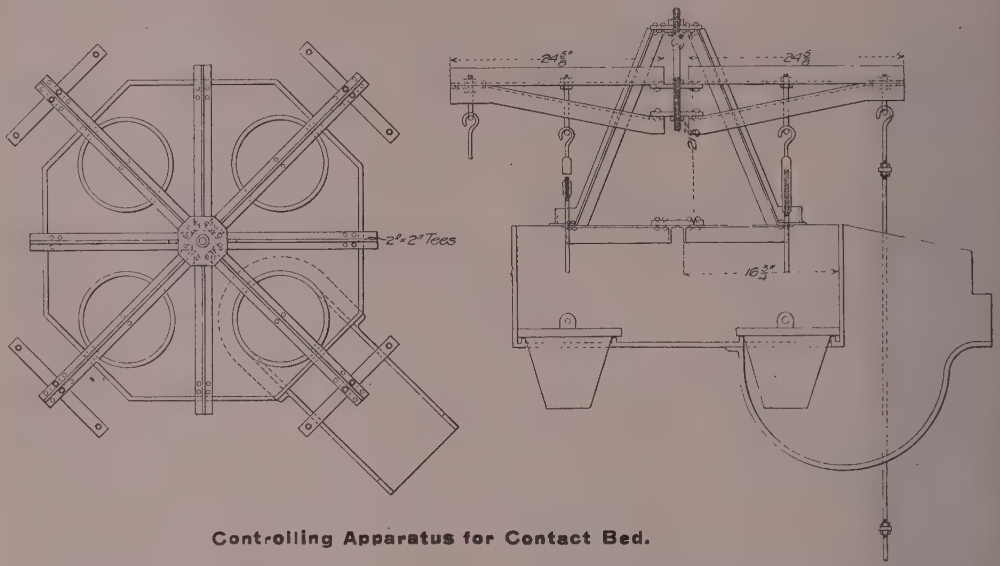
The Septic Tank.—The septic tank proper is built of concrete composed of one part of Atlas Portland cement, three parts of sand and five parts of furnace slag, and is covered with a brick-walled and shingle-roofed 28x85-ft. building. The tank is divided into three compartments; a 12x26-ft. receiving chamber is placed across one end of the building and the remaining space is divided by a longitudinal wall into two tanks, 8 ft. 6 in. by 67 ft. 4 in. and 14 ft. 4 in. by 67 ft. 4 in. The partition walls in the tank are not designed to withstand the pressure which would be imposed on them if one compartment was full and the others empty, and openings were left through the walls near the floor of the tank so as to equalize the pressure. If one compartment is to be cut out the flow through it is simply shut off and the sewage is allowed to remain in it.

The 18-in. outfall main from the sewerage system of the Home enters one end of the receiving chamber with its invert at the water line, about 7 ft. above the bottom of the chamber. About the entrance is placed a baffle, consisting of a sheet of galvanized-iron bent in a semi-cylindrical form. This baffle extends 4 ft. below the surface of the sewage in the chamber and its edges are placed 3 ft. from the end wall. It is intended that anærobic action shall begin in the receiving chamber, and for this reason baffles like that at the inlet are provided in front of each of the four outlets from the chamber. Two of these outlets lead into the main septic compartments, one to a 10-in. overflow pipe and one into a concrete outlet channel, through which the effluent from the receiving chamber may be discharged directly to the contact beds without passing through the two main compartments of the tank. The receiving chamber is also designed to serve as a grit chamber, and its bottom therefore slopes from all directions toward a 6-in. lift valve through which grit and sludge can be flushed into the general washout system of the septic tank.

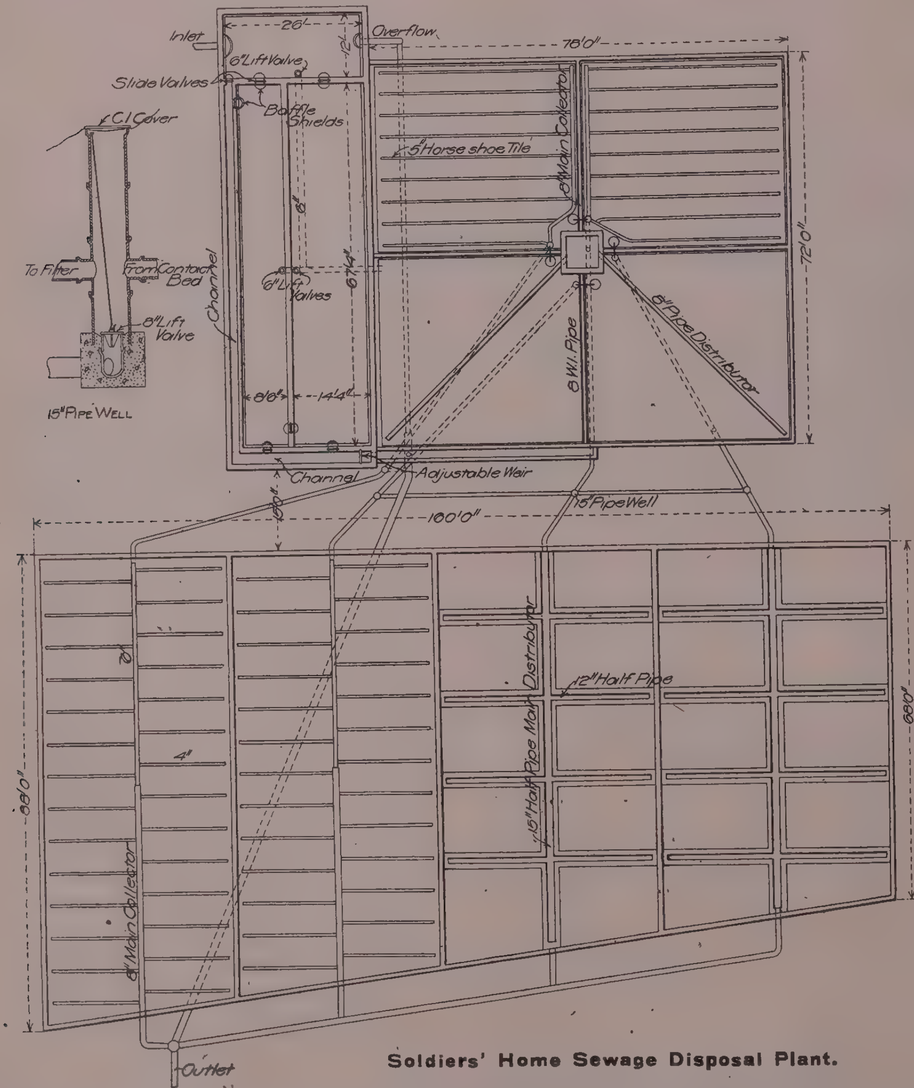
From the receiving chamber the sewage passes into each of the main compartments through an opening in the division wall, 12 in. wide and extending 4 ft. below the water level. These inlet passages are provided with boiler plate slide valves working in cast-iron grooves embedded in the wall. Baffle shields in the main compartment, similar to those in the receiving chamber, distribute the sewage through the tank below the surface. At the outlet end of each main compartment the effluent passes out through a baffled aperture similar to that at the inlet end and into the outlet channel extending across the end of the building along one side of the receiving chamber. It is 1½ ft. wide and about 2¾ ft. deep. In this channel, below all the outlets, is an adjustable weir with a range of 24 in. with which the capacity of the tank can be increased or diminished. By means of this weir and the slide valves with which the large compartments can be cut out, the period of septic action can be varied from a maximum of about 8 hours to a very short time.

The Contact Beds.—The 78x72-ft. area occupied by the contact beds is contiguous to the septic tank, one long wall of the tank being also the wall for one side of two beds. In the center of this area is the controlling apparatus with which the sewage is turned from one bed to the next. From the controller radiate four walls which divide the area into four contact beds, each 34.5x37.5 ft. in plan inside and about 6 ft. deep. The outside and partition walls are of concrete mixed in the same proportion and made of the same materials as that used in the septic tank, and reinforced with barbed wire. The contact material is furnace slag free from dust, the pieces being 1 in. in diameter or smaller. This was secured from the Cranberry Furnace Co., in Johnson City.

The sewage leaving the septic tank is carried to the contact beds in a concrete channel and across the beds to the controlling apparatus in an 8-in. wrought-iron pipe laid on one of the division walls. In the concrete channel about 8 ft. from the septic tank is a sump, at the bottom of which is a 10-in. seat valve through which the effluent from the septic tank can be diverted directly to Brush Creek without passing to either the contact or filter beds.



Controlling Apparatus for Contact Bed.



Soldiers' Home Sewage Disposal Plant.

The controlling apparatus consists of a cast-iron box, octagonal in plan, in the bottom of which are four seat valves, each connected to the distribution system of one bed. Over the center of the receiving box is a hook from which is supported by a ring a four-arm rocking frame, each arm attached to the seat valve directly beneath it. When the rocking frame is in a horizontal plane, all four valves are closed. By means of a weight on a swinging arm the plane of the rocking frame is thrown out of the horizontal in such a manner that the valve diagonally opposite the weight is lifted while the other three remain closed. When the bed which receives the effluent passing through this open valve is filled to a certain level it overflows through a system of small pipes leading back into the controlling chamber. The overflow passes into a bucket hanging from the rocking arm diagonally opposite the bed which is to be filled next. The weight of the water in this bucket is sufficient to tilt the rocker frame, closing one valve and opening the next and at the same time causing the swinging arm with the weight to pass through a horizontal angle of 90 deg. and settle in a position diagonally opposite the newly opened valve. When the water in the overflow bucket drains out through a small hole provided for this purpose, the weight on the swinging arm keeps the rocking frame tilted so that the valve opened by the weight of the water bucket stays open when the bucket is empty. When the second bed is filled to a certain level the next valve is opened in a similar manner, and so on throughout the complete cycle. The change from one bed to the next can be made at any time when the water surface of the filling bed has reached any one of four levels, at each of which there is an outlet and stop-cock on the overflow pipe.

For emptying the beds a special device has been designed, four separate sets of which are used. Each set consists of a float in one bed connected by a system of levers to the valve in the bottom of an adjacent bed, so that when the float is raised the valve is also lifted. When a bed has been filled the next in order is always the one containing the float which is connected to the valve in the first bed. The float operates freely in a vitrified pipe well and can be adjusted so that at any level it will rise and open the valve in the bottom of the bed, which has been standing full. The float will then hold this valve open until the bed next in the cycle has been filled and in filling has caused the second bed to begin to empty. These inlet and outlet controlling devices make it possible to vary the period of contact through wide limits.

In order to prevent the effluent from the septic tank from showing on the surface of the contact bed, the 8-in. round vitrified sewer pipe distributor into which the effluent is discharged from the controlling chamber is covered with the contact material. This pipe extends diagonally across the bed and is laid with open joints through which the effluent escapes. Practically the only difficulty which has been experienced in the operation of the plant was due to the fact that the contact material around the joints of the distribution pipe became clogged with solid matter like silt, which caused the effluent in the contact controller to back up and overflow into the controlling chamber. This was remedied by uncovering the distribution pipe and digging shallow trenches in the contact material at right angles to the pipe. The contact beds are underdrained with rows of 5-in. horseshoe tile spaced 4 ft. center to center and draining into a main collector consisting of 6-in. and 8-in. round vitrified sewer pipe. The main collector in each bed discharges into a valve well at the bottom of which is an 8-in. seat valve operated by a float in an adjacent bed, as already explained. The four main discharge pipes leading from the contact beds to the filters are intersected by an 8-in. vitrified pipe line, which connects with a 15-in. pipe and through which the effluent from any or all contact beds may be discharged into Brush Creek without passing through the sand filters. The waste pipe passes under those leading to the filters and at each intersection a well made of 15-in. sewer pipes is provided with an 8-in. lift valve in its bottom covering the entrance to the waste pipe.

The Sand Filters.—The total area of the four sand filters is 12,480 sq. ft., or 0.287 acre. With an estimated maximum sewage discharge of 300,000 gal. per day these filters will operate at the rate of 1,045,000 gal. per acre per day. This high rate was considered permissible in designing the plant because the sewage is first treated in both the septic tank and the contact bed. The filter beds are without floors other than the clay upon which the filtering material rests, but are separated and surrounded by concrete walls 8 in. thick and about 5 ft. high, made of a 1:3:7 mixture of Atlas Portland cement, sand and slag. The filtering material is clean, sharp river sand obtained near by on the bank of the Watauga River. Mechanical analyses of four samples of this sand taken from each of the four beds show a variation in the effective size of 0.29 to 0.31 mm. The uniformity coefficient varied from 2.06 to 3.14 and the percentage of dust ranged from 0.86 to 1.26.

The effluent is distributed over the surface of the filters by means of vitrified half-pipe. The main distributor is a 15-in. pipe and the branches are 12-in. These are laid with open joints and closed ends, and each line is placed on a bed of broken stones to prevent the discharge of sewage from washing away the filter sand.

The clay floor of each filter is covered with 6 in. of coarse gravel and the sand over it has an average depth of about 3½ ft. In the layer of gravel is placed the collecting system, which consists of cross lines of 4-in. farm tile spaced 6 ft. center to center and emptying into a main collector of 6-in. and 8-in. vitrified pipe extending along the longitudinal center line of each bed. The four main collectors discharge into a manhole from which an 18-in. pipe leads to Brush Creek.

The disposal plant was designed and built by Messrs. Williams & Whitman, civil and sanitary engineers, New York City, under the immediate supervision of Mr. R. F. Proctor, and cost the United States Government about $18,000 to $20,000. Messrs. Williams, Proctor & Potts, New York City, are successors to Messrs. Williams & Whitman.

The 175th Street Arch and Approaches, New York.

The construction of the Grand Boulevard and Concourse from 161st St. to Mosholu Parkway, in the Borough of the Bronx, New York City, now under contract, includes an earth and masonry viaduct about 800 ft. in length, carrying the Concourse across the valley and over 175th St., which is spanned by an elliptical arch of 66 ft. span and 20 ft. rise, built on a 9-deg. skew. At the present time the masonry approach walls are completed to their top under coping, the filling between them is partly made and the arch abutments completed.

The retaining walls approaching the arch are 172 ft. apart face to face under coping, varying in height from about 6 ft. at the ends to 51 ft. near 175th St., and are built with a 1:12 batter. They are broken range, ashlar faced, with backing of rubble masonry, all laid in Portland cement mortar. The width on the top is 2 ft. and the back is offset with regular 12-in. steps to the base, where the width at maximum height is 21 ft. They are to be coped with granite, face and wash fine dressed, and upon this coping a fine cut granite parapet wall is to be built, broken every 90 ft. by large, ornamental granite pedestals, which are corbeled out beyond the plane of the face of the retaining walls. The spandrel walls over the arch and abutments are to be vertical and 181 ft. 6 in. apart face to face; they are to be of the same class of masonry as in the retaining walls, except that the quoins are of granite with 3-in. rock face and 1-in. chisel draft on all exposed edges.

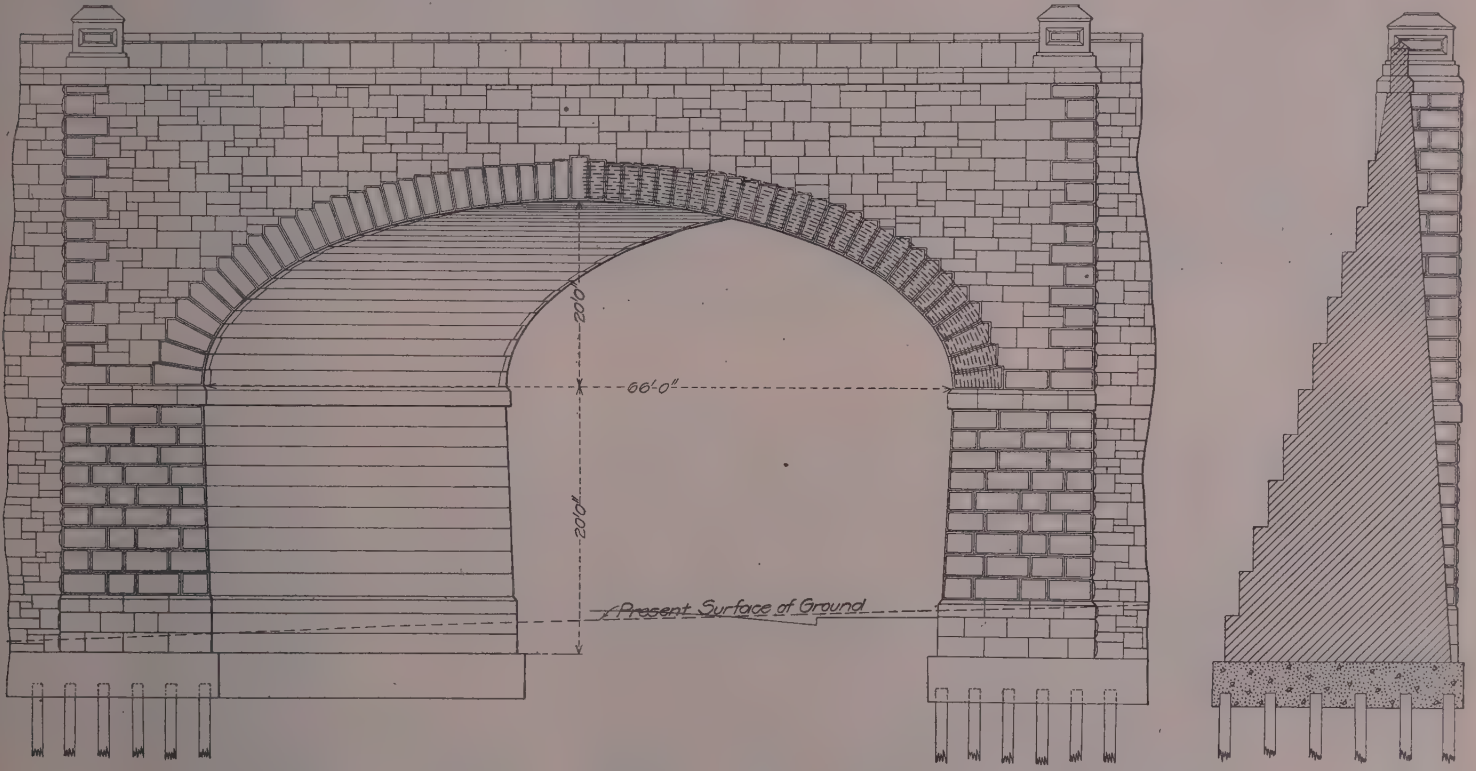
The arch abutments are 20 ft. high from top of footings to skewbacks, with a width of 12 ft. at the latter point. They are of coursed granite backed with rubble, the third course above the footing being a fine cut belt course. The courses below the belt course are rock face, those above the belt course and below the skewback or coping are also rock face, each stone, however, having a 1-in. chisel draft on all edges. The skewback or coping course is of fine-cut granite.

In preparing the footings for the arch abutments it was found necessary to modify the plans very materially, the piling called for was omitted, and the excavations taken down to an excellent bottom of sand and gravel. The footings are of cyclopean masonry, generally 22 ft. in width at bottom and from 15 to 20 ft. in depth.

The arch ring, except the soffit course, which is to be buff vitrified brick, is to be of hard burned brick 40 and 48 in. in thickness at the crown and spring, respectively, faced at the portals with granite voussoirs in the planes of the spandrel walls, and extending into the ring parallel with the axis of the arch 3 and 4 ft. alternately to bond with the brickwork. They are to be fine cut on the soffit and rock face in the vertical plane with a 1-in. chisel draft on radial and 2-in. draft on all other edges.

A full-size, half-right section of the arch has recently been laid out on a large floor, and templates for the arch ribs and for each voussoir are now being made. It is expected that the entire work will be completed during the coming summer. The estimated cost of the viaduct is $215,000.

The structure has been designed and is being constructed under the direction of the engineering department of the Borough of the Bronx, Mr. Josiah A. Briggs, chief engineer; Mr. S. C. Thompson, engineer of highways, and Mr. R. H. Gillespie, assistant engineer. The Uvalde Asphalt Paving Co. is the contractor.



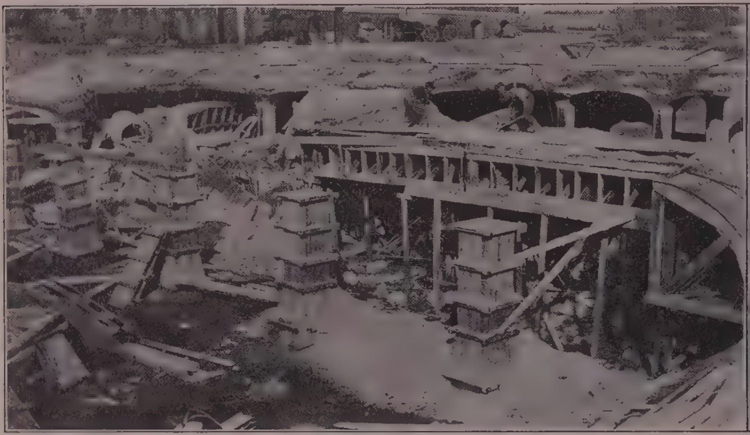
Elevation of Brick Arch at 175th Street, New York, and Section of Approach Wall.

Underground Rock Crushing is done in the mine of the Smuggler Union Mining Co., at Telluride, Colo. Two Gates ore breakers have been set up in one of this company's tunnels and used to reduce the ore underground to a convenient form for handling before it is lifted to the surface. Both crushers are driven by induction motors.

The Collapse of Concrete Roof Arches at the Lawrence Filter.

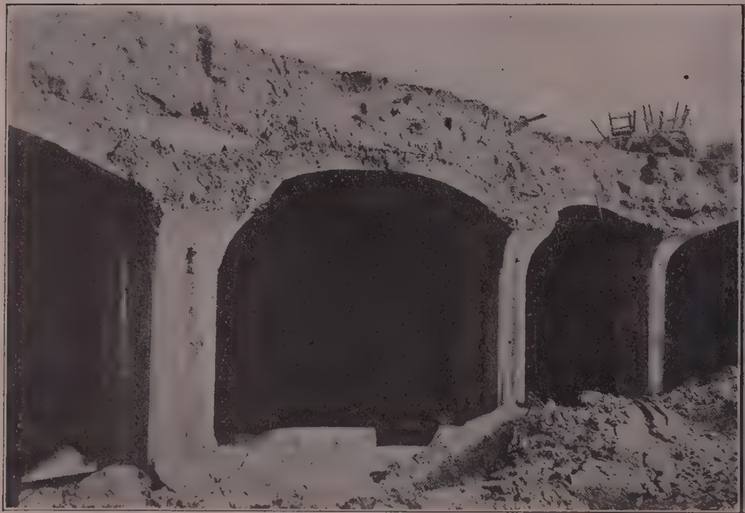
By John F. O'Connell.

On the morning of April 3, a section of the concrete arched roof of the Lawrence, Mass., filter, now under construction, collapsed and a large portion was completely wrecked. The section to go down was all laid during the latter part of 1906, when frost had manifested itself. The area wrecked was 67 x 100 and aside from this a considerable section will undoubtedly have to be removed, as cracks appeared immediately after the collapse of the other portion. The loss to the contractor, besides a month's delay in the work, includes the forms for the elliptic groined arches the removal of which precipitated the crash and the forms were crushed beneath the weight of the roof. No official investigation of the cause of the accident has been made as yet, but it is thought to be due to the action of frost upon the concrete before it had set, as concrete roof arches of similar design have been used in other structures and have been found to be thoroughly satisfactory. An examination of the wrecked concrete also bears out this supposition.

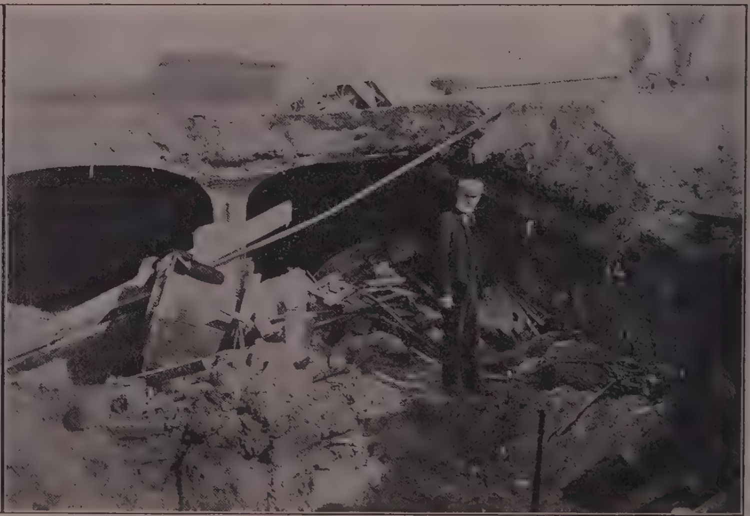


View Looking Northeast over Filter.

Manhole Frame Unbrokenby Fall.



Fourth Line of Piers.



The South Barrel Arch.

The collapse occurred at about 10.30 o'clock in the morning, while a number of workmen were taking down the wooden forms, which had supported the roofed-over section during the winter. The actual collapse was preceded by a distinct rumble and a crackling sound which gave the workmen warning and all had fled to a place of safety before the roof and arches fell with a crash. The section of the roof which fell was almost entirely laid in December of last year, when the temperature was above the freezing point during the day, but during the nights the mercury dropped below the 32° mark.

All cement work was tested thoroughly and the ordinary precautions were taken to prevent frost getting in its destructive work before the material had set. As soon as a certain portion was laid, the men would protect it with a heavy covering of straw, placing over this a generous coating of manure, and the contractors felt that the coating was warm enough to thoroughly protect the newly placed material from the weather.

About the middle of December, nine of the twenty lines of piers had been set and eight lines covered with the roof. The westerly edge of the finished roof was then firmly braced to the base of the ninth line of piers, and the work was stopped for the winter.

Work was resumed the day before the accident occurred, the first thing called for being the removal of the forms to use in working ahead. About 30 ft. of centers had been taken down, the westerly 15 ft. remaining in place, when the roof dropped.

The concrete which fell showed plainly the effects of frost having entered the material, some of it being still soft while other sections were perfectly solid. The piers, which were set during October and November, in nearly every case fell in one piece or remained upright without fracture, and sections of the roof 6 ft. square fell without cracking.

After the collapse, a crack about ¼ in. in width, appeared in the section of the roof between the third and fourth lines of piers and another crack showed on the outer face of three of the piers on the fourth line, which support the westerly edge of the roof remaining in place. Since the accident a crack has been discovered in the roof over the third line of piers, all undoubtedly due to the loss of the bracing against the westerly thrust of the roof arches.

In view of the nature of the accident and the circumstances surrounding it the following might be of interest: The contract called for the work being completed on or before Nov. 15, 1906, but the time was later extended by the city council to Dec. 15, and in this month was again extended to Aug. 1, 1907, the contractor claiming that the labor market was poor and he was handicapped in getting help. The specifications thoroughly covered every exigency and the city seems to be protected at every point, as shown by the following excerpts:

"In case any unforeseen contingencies arise which will prevent the work being completed by Nov. 15, 1906, and it becomes necessary to do work in the winter weather, no embankment shall be made and no concrete shall be mixed, nor placed nor masonry laid, nor any other operation performed, likely to be interfered with by cold during any of the months of December, January, February and March and thereafter until the frost is out of the ground, unless permission be obtained from the Engineer. If, however, the Engineer is of the opinion that any operation can be satisfactorily performed during these months, he may give the Contractor a special written permit, which permit shall define the work and the conditions under which such work may be done and such conditions shall be faithfully followed.

"The Contractor shall be responsible for all defects in the work done during these months which may arise from the action of the elements, notwithstanding such permit and additional precautious taken. He shall make good such work and shall make good any work destroyed or damaged by the frost, even though built at any other season of the year.

"The Contractor shall be held responsible for any and all materials and work to the full amount of all payments made thereon, and he will be required to make good at his own cost, any injury or damage which said material or work may sustain from any unforeseen obstructions or difficulties which may be encountered, or from the action of the elements, or from any source or cause whatsoever before final acceptance thereof."

The mixture specified for piers and roof arches is one part of cement, three of sand and five of clean gravel or broken stone; the contractor used gravel. The roof was to be covered with 3 ft. of earth filling and the part completed had been covered with about two feet at the time of failure.

The filter was designed by Messrs. Chapin & Knowles, of Pittsburgh, Pa., and was being constructed by Mr. M. O'Mahoney, of Lawrence. The design of the roof is similar to that of the Pittsburgh filter, consisting of a series of groined arches resting on piers 15 ft. center to center, as shown in the accompanying diagram. The arches have a rise of 2 ft. 9 in. and a thickness of 6 in. at the crown. From the side walls, barrel arches are sprung, 2 ft. thick at the springing line and uniting with the groined arches at the crown. The piers are 22 in. square at the top with a base 2 ft. 6 in. square and are 8 ft. 9 in. in height. (For detailed description of filter, see The Engineering Record of May 19, 1906.)

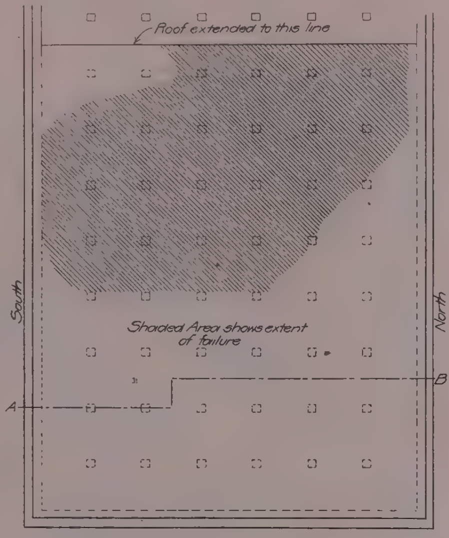
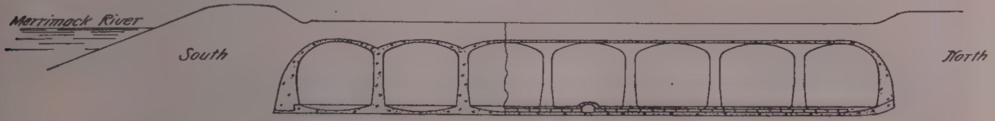

Roof extended to this line
South
North
Shaded Area shows extent of failure
A
B

Diagram of Fallen Filter Roof.



Section on A B of Diagram of Filter Roof.

Looking Northeast over Filter.

Looking Southeast over Filter.

The contract was let in May and work was begun early in June. The price bid for concrete in piers and roof was $5.57 per cubic yard.

The accident to the new filter at this time is decidedly unfortunate in view of all the circumstances. The new filter was started only after years of agitation on the part of the water department officials, who felt that each winter a famine was bound to occur on account of the old filter being too small for the growing demands of the rapidly increasing city.

As soon as cold weather set in it was found that the old plant would not supply the city and as the water in the reservoir fell lower and lower each day it was found necessary to connect first with the Andover water system and shortly after with the North Andover works, the city paying the towns at the established rates. During most of the winter this has been the situation, and it develops that the accident to the filter will so delay the work that it looks as if the city will be obliged to rely on the auxiliary supply from the towns again next winter. When the contractor was given his second extension of time it was understood that he would complete the new plant early enough in the summer or autumn, so that the old filter could be roofed over and fitted up, increasing the capacity and improving conditions so that the city would be safeguarded from a water stringency for years. From present indications it appears well nigh impossible to do any work on the old filter, during the coming summer.

A 2-Ft. Gauge Railway has recently been completed at Swakopmund, German Southwest Africa, running about 150 miles from the seacoast into a copper mining district.

The Weight and Settlement of Crushed Limestone.

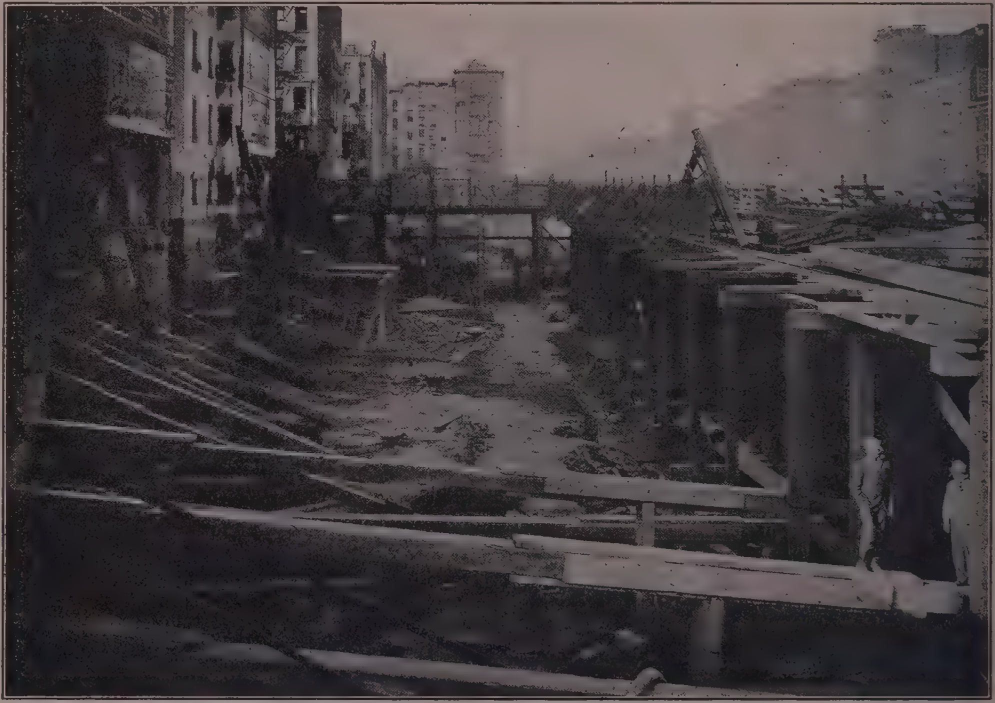
A series of tests was conducted recently by the Illinois Highway Commission, under the direction of Mr. A. N. Johnson, State Highway Engineer, at the State rock crushing plants at Menard and Joliet to determine what should be called a cubic yard of crushed limestone. Both cars and wagons were loaded in different ways and hauled different distances. The contents of each car or wagon were carefully measured and weighed, and on arrival at destination again measured, so that the variation in the density of the load due to method of loading, to size of material and to settlement, was determined. The results of these tests, according to the annual report of the Illinois Highway Commission, indicate that the average weight of the wagon loads of limestone, including all sizes, was at the start very nearly 2,400 lb. per cubic yard, varying somewhat, according to the method of loading, and that the weight of a cubic yard in a wagon after it had been hauled a distance of one-half mile was a little over 2,600 lb. Also that the weight of a cubic yard of stone, as loaded in the cars, is but a few pounds over 2,400 and after settlement 2,600 lb. As the weight of a cubic yard depends very considerably on the method of loading the car or wagon, and also as to the amount of settlement due to the length and character of the haul, the determination of what shall be the weight of a cubic yard is somewhat arbitrary. In view of the results of these tests, the State Highway Commission has adopted 2,500 lb. as the weight of a cubic yard of crushed limestone at both the Menard and Joliet crushers.

Tests were also made to determine the settlement of crushed stone in wagon loads for different hauls. The road over which the tests were made is a macadam road, not particularly smooth, but might be considered as an average road surface. The wagon used was one with a dump bottom supported by chains, which were drawn tight as possible, so as to reduce the sag to a minimum. About 50 per cent. of the settlement occurs in the first 100 ft. and 75 per cent. of the settlement in the first 200 ft. Almost all of the settlement occurs during the first half mile, as the tests showed practically no additional settlement for distances beyond. Some of the wagons were loaded from the ground with shovels, others were loaded from bins, the stone having a 15-ft. drop which compacted it a little more than where loaded with shovels, so that there was a little less settlement.

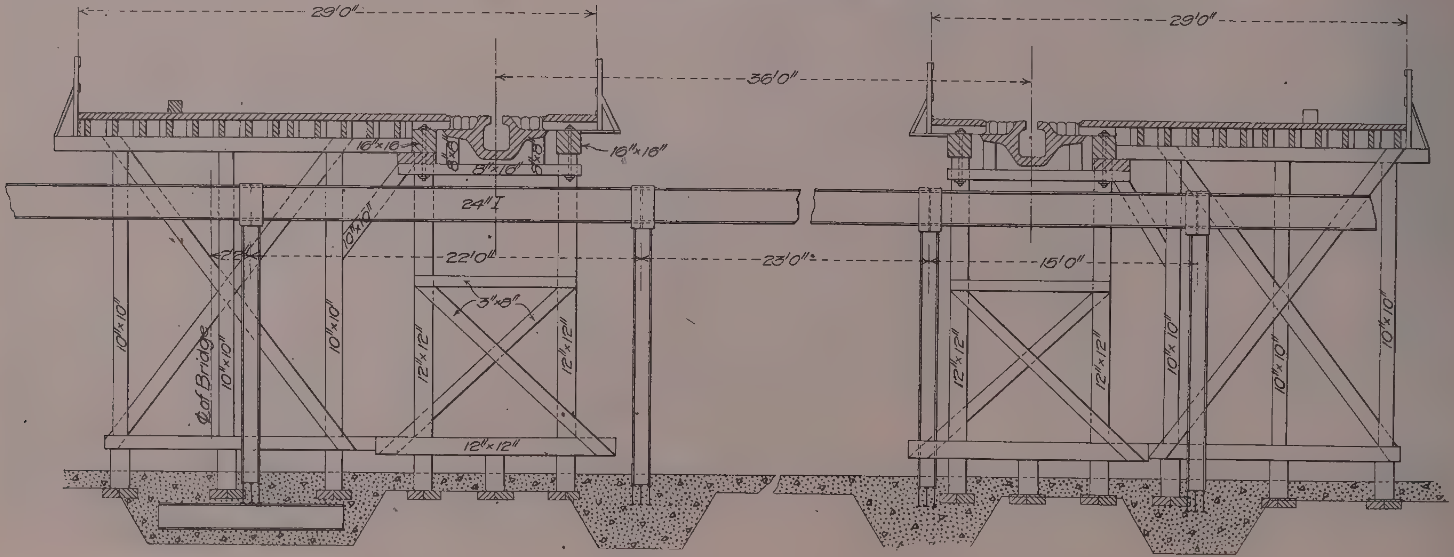
Preliminary Construction for the Manhattan Subway Station at Williamsburg Bridge.

The Manhattan subway station for the Williamsburg bridge, New York, provides an eight-loop terminal for surface cars crossing the bridge from Long Island and also provides a 620-ft., two-track terminal for elevated trains available for future connections with the subway system in Manhattan. This part of the station will, except the entrances, be built entirely below the grade of the street and will be located at the west end of the bridge under the surface of Delancey St., reaching from Essex to Clinton Sts., with extreme dimensions of about 200x800 ft. It involves an excavation about 24 ft. below the curb, in which a steel and concrete structure will be built with a flat roof carrying the present surface tracks, sidewalks, and roadways. The type will be similar to that of some parts of the subway construction with riveted vertical posts, steel beams and girders, reinforced concrete floor sidewalls and roof-slabs. Some of the principal quantities involved are about 95,000 cu. yd. of excavation; 20,000 cu. yd. of concrete; 4,000 tons of steel and about 600,000 ft. B. M. of falsework and trestle lumber. The contract was awarded by the Bridge Department at an estimated price of $1,167,000 to the Snare & Triest Co.

Operations were commenced last August on the south side of Delancey St., between Norfolk and Clinton Sts., where most of the old brick dwellings, from four to six stories in height, were found to be in a very dilapidated and unsafe condition. These were underpinned by the usual needlebeam method with trenches carried down to a depth of about 26 ft. below the curb, and concrete footings and rubble masonry foundations built in them. The contract requires that the two lines of surface tracks on Delancey St., 30 ft. apart on centers, and two roadway strips 20 ft. wide, one on each side of the car tracks, shall be maintained for unobstructed traffic during the progress of the work. In compliance with this requirement, the excavation was divided into several successive portions, the first of which involved the removal of 25,000 cu. yd. of material in a 90x400-ft. area between Norfolk and Clinton Sts., reaching from the south side of the terminal to a line 5 ft. south of the southern car track. As soon as this excavation was completed to subgrade, trestle bents were erected in it to support a longitudinal timber deck 20 ft. wide from end to end of the excavation to carry the vehicular traffic on the south side of the railroad tracks. The excavated material consists of fill, earth, sand, mud and miscellaneous material down to a point several feet below the water-table of ground water, but does not reach to solid rock. Much of it was hard enough to stand in steep, high faces, without sheeting, but on the south side where the houses were some distance back from the line of excavation, it was necessary to retain the earth with square-edge sheet piles driven by hand and braced by the ordinary methods with waling pieces and inclined struts. The excavation was done entirely with pick and shovel, and the material was removed by teams in wagons drawn up a ramp at the west side of pit where the slope was so steep that a hoisting engine was installed at the upper end to pull the wagons out of the excavation.



Excavation and Timbering for First Section of Work.



Transverse Bent of Steelwork and Temporary Traffic Trestle.

The second section excavated is also 400 ft. long, and was bounded by east and west lines 5 ft. beyond the outer rails of each track. The excavation was accomplished in the open pit between the tracks and by undermining from the pit already dug on the south side. The surface tracks have cast iron yokes and concrete conduits carrying the track rails and inclosing the electric conductors. This construction was left undisturbed. In order to provide for its support the pavement was removed outside the rails and shallow longitudinal trenches were dug in which were laid, about 4 ft. on each side of the center line, continuous lines of 16x16-in. pine timbers, some of them as much as 80 ft. long. Vertical holes 5 ft. apart were bored through them on the center line, and in each hole was placed a 2-in. bolt about 2½ ft. long with nuts and washers at both ends. A deck 3 ft. wide made of 4-in. longitudinal planks, was supported on the center line of each longitudinal beam and protected by a strong wooden fence on the outside, thus providing for pedestrians and for the horses which draw some of the cars using these tracks. Transverse 4x13-ft. pits 15 ft. apart on centers were dug to sub-grade under the tracks, and in them were set single trestle bents supporting the 16x16-in. longitudinal timbers. The earth under the tracks was then removed by excavation made from vertical faces on both sides, and as soon as sufficient space was provided, 8x16-in. needle beams 10 ft. long were placed transverse to the track and supported by the vertical bolts already mentioned through the longitudinal timbers. By this means the track was safely suspended from the trestle false-work while the excavation was completed.

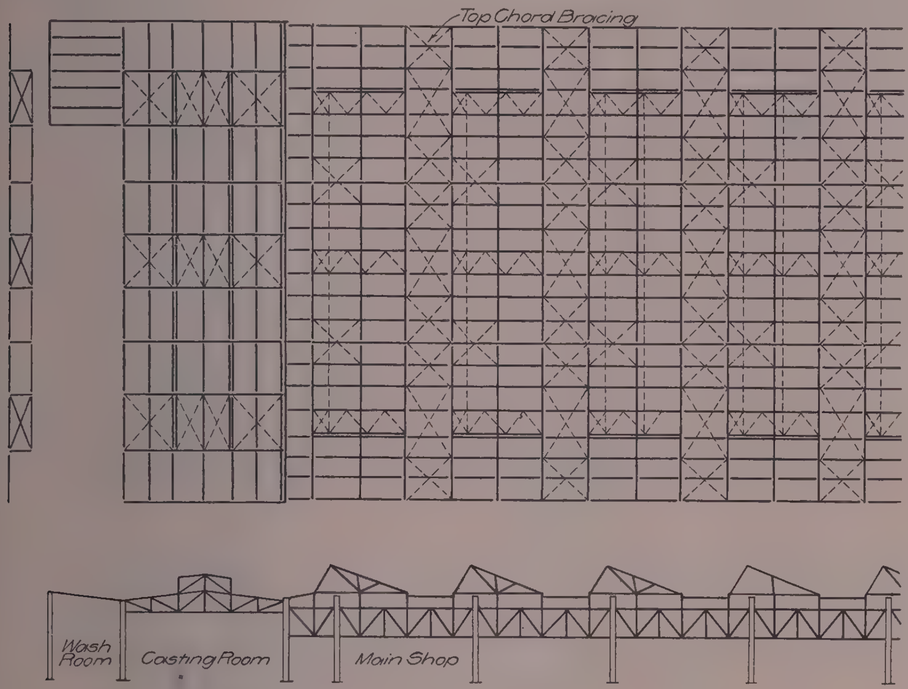
The trestle bents are of special construction and were in the first place made independent for the car tracks and for the roadway platform. The former were each made of two 12x12-in. vertical posts 10 ft. apart, seated on 12x12-in. sills 13½ ft. long, which are elevated 2 ft. in the clear above the subgrade and supported on three short vertical posts with grillage plank footing, thus enabling the upper trestles to be jacked up free of the footing and moved from place to place if necessary to provide for laying the concrete invert. The transverse X-braces terminated 6 ft. below the track conduit to clear the steel work in the roof of the subway structure. The trestle bents under the roadway platforms were similar, except that they were made of several 10x10-in. vertical posts 6 ft. apart on centers and the transverse X-bracing was arranged to clear the steel work of the subway structure passing between its beams to the upper ends of the vertical posts. At the end of the terminal the falsework bents for the roadway and railroad tracks are continuous, as indicated in the accompanying elevation.

Before the third section of excavation is commenced, a second roadway platform 20 ft. wide, parallel with the street car tracks, will be built on the north side of the track to carry one-half of the street traffic, and the remaining 20 ft. of the width of the terminal will be excavated to the north side curb, thus completing the excavation between Norfolk and Clinton Sts. Afterward the excavation between Norfolk and Essex Sts. and east of Clinton St. will be made, completing the work.

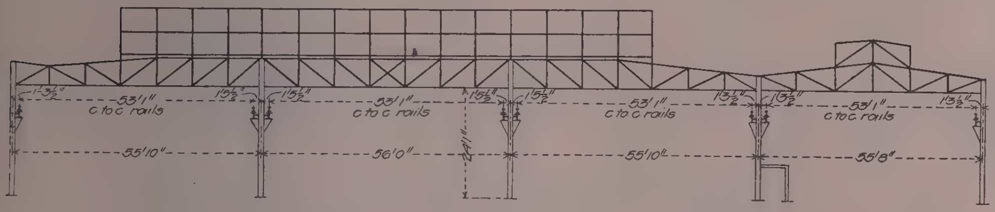
Hot-Water Heating with mechanical circulation of the warm water is being installed in a small shop near New York in connection with a gas engine plant. The factory will require about 400 h.-p. in gas engines, and arrangements will be made to utilize all the heat in the jacket water and exhaust gas, practically 50 per cent. of the heat furnished to the engine, for warming. According to Mr. J. A. Almirall, of New York, supplementary boilers will be installed for use at such times as these waste sources may furnish insufficient heat.

The Steel Framework of a Shop for Light Metal Work.

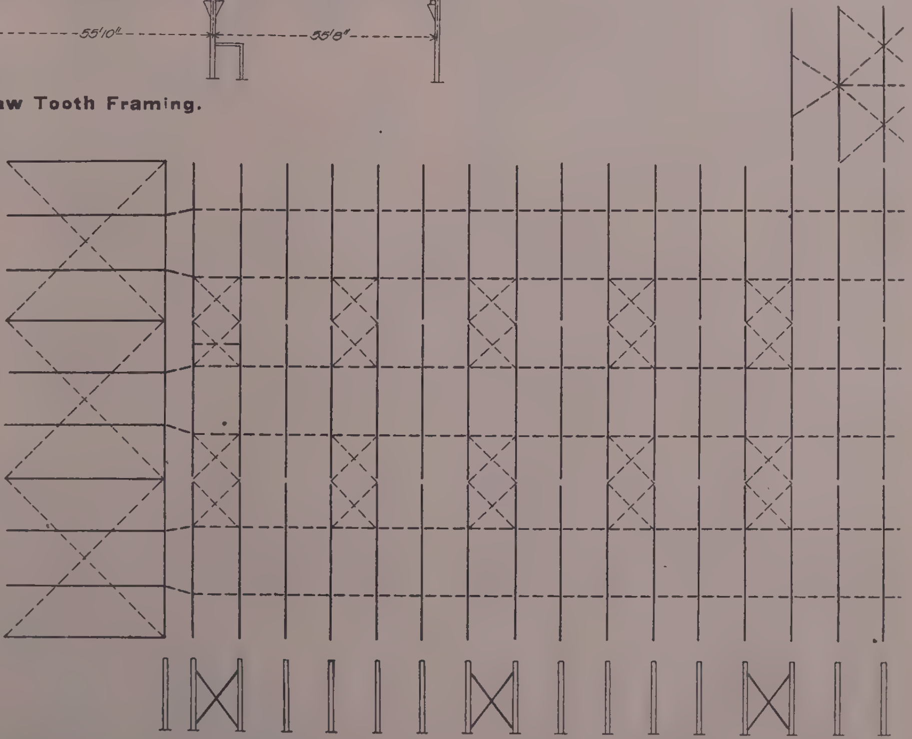
The steel work of a large shop recently built for light foundry and metal work was very carefully designed to secure minimum weight and avoid interior obstructions, to provide for extensive traveling crane service, to take care of roof lighting and drainage, and to secure simplicity and duplication of members, thereby promoting economy in fabrication and erection. The details conform to advanced practice for industrial buildings of this character and the general features of the framework present some special points of arrangement.



Part Longitudinal Section and Plan of Purlins.



Section and Elevation of Saw Tooth Framing.



Part Plan of Roof Truss and Lateral Bracing.

The building is about 32 ft. high to the general roof level and covers a 167-ft 8-in. by 622-ft. rectangular area, exclusive of a 25x37-ft. washroom extension and a 56x128-ft. power house annex, the latter having a tower 18 ft. square and 60 ft. high and being commanded by a 10-ton traveling crane. The main shop is divided into three longitudinal aisles about 56 ft. wide and 571 ft. long, each served by two full-span, 5-ton cranes traveling from end to end. At one end of the building the longitudinal aisles terminate in a transverse aisle 51 ft. wide and 168 ft. 8 in. long, which is used as a casting room.

The main shop has a saw-tooth roof with the saw-tooth frames supported on transverse trusses 16 ft. apart, which are carried by steel columns in the exterior walls and by two intermediate lines of lattice girders supported on columns 48 ft. apart. The casting room roof is supported by triangular transverse trusses 18 ft. 8 in. apart, all of them being carried directly by columns in the end wall and by a parallel interior row of columns. This construction includes 98 main columns, besides those carrying the casting house roof, and 37 lines of main transverse trusses and 26 longitudinal trusses, exclusive of those in the power house and wash room.

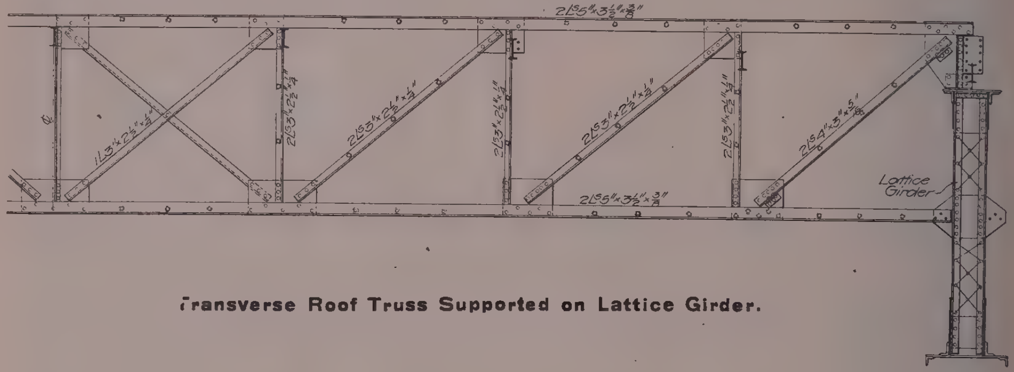
Owing to its comparatively small height, great lateral dimensions and the depth of the connections between the columns and trusses, the building has exceptional rigidity, and its stiffness and inertia are far greater than are requisite for any computed wind stress. Lateral systems, all of riveted single angles, are, however, provided by X-braces in all the panels of the lower chords of the casting house roof and in the main shop in every third panel between the lower chords of the transverse trusses. Additional lateral braces are provided in the power house and there is X-bracing of screw rods in the end panels and in four intermediate panels between columns in the side walls.

The columns have I-shaped cross-sections made of two pairs of flange angles and a solid web plate, and, except those in the end walls and in the casting room, have their webs transverse to the axis of the building. The wall columns are all built into the brickwork, with only the outstanding legs of the inner flanges projecting beyond the face of the wall. The outer flanges of the columns are protected by 4-in. extensions of the brickwork forming exterior buttresses about 2 ft. wide. All columns are seated on pyramidal concrete piers, to which they are secured by 1¼-in. anchor bolts 4 ft. long. The latter are made with a slight curve in the middle to increase their bond with the masonry and have 6x½-in. anchor plates 12 in. long bolted to the concrete to receive their lower ends in pairs. The regular side-wall columns carry 30-ton loads and each is anchored by two bolts to piers 2 ft. square on top. The interior columns have 120-ton loads and are anchored with four bolts to piers 3 ft. square on top. Power house columns have from 25 to 71-ton loads and two anchor bolts in piers 2½ ft. square.

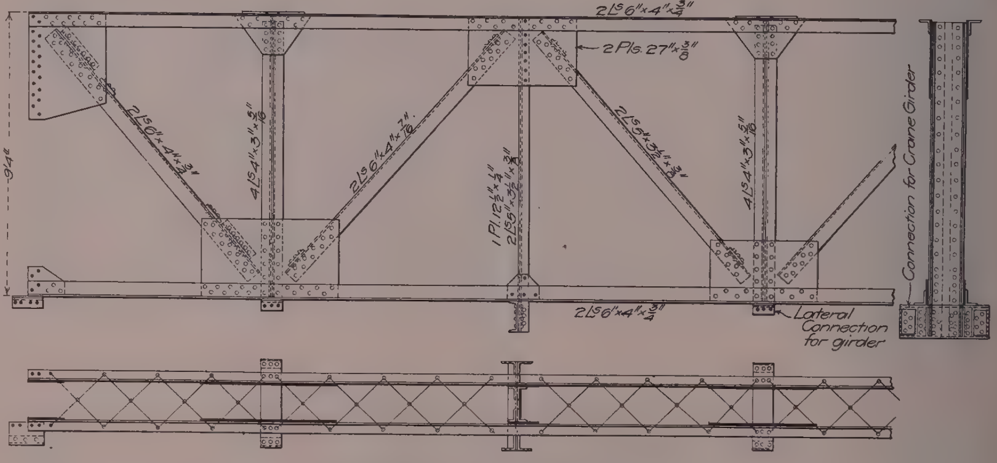
The side-wall columns are made of 5x3½x5/16-in. full-length flange angles about 30 ft. long and a 12x5/16-in. web plate which terminates about 7 ft. below the top of the column, leaving a space between the flange angles to receive the projecting end of the web in the transverse roof truss, which is field-riveted to the column, thus making a very deep connection and securing continuity between the members. It is also spliced to the column web by a pair of 5x⅜-in. cover plates shop-riveted to the column. The inner face of the column is provided with a solid web bracket to receive the 15-in. I-beam girder for the crane runway.

The interior columns in the longitudinal rows through the main shop have to carry 48-ft. longitudinal girders supporting the transverse roof trusses and two lines of traveling crane runways, which, altogether, produce 120-ton loads and require cross-sections made of pairs of 6x4x½-in. flange angles and a 14x⅜-in. web plate. The 28x28x¾-in. base plates are stiffened by extended flange plates and 6x6-in. connection angles riveted to the foot of the column. The 15-in. runway girders are carried on twin solid-web brackets made of short sections of web projecting equally on both sides of the column and loading it symmetrically.

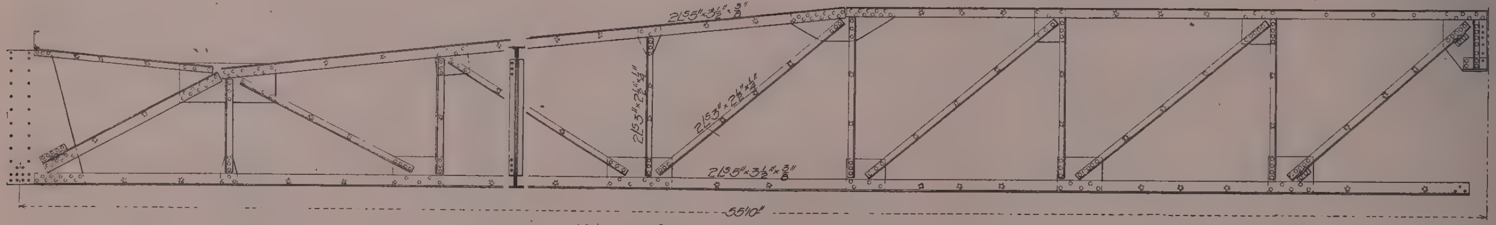
Field-rivet holes in both flanges of the column near the upper end provide for connections to the longitudinal girders, which have their top flanges about 2¼ ft. below the column caps. The column caps are field-riveted to horizontal longitudinal members in the saw-tooth trusses. The lower ends of the columns between the main shop and the power house are similar to those in the interior longitudinal rows, having beveled runway girder brackets to provide for the crane service in the power house. The 12x5/16-in. web plates terminate about 4½ ft. below the tops of the columns, where they are shop-spliced to special sections of web plate, which project about 3 ft. beyond each flange of the column and serve as gusset plates for the connections to the roof trusses over the power house and over the side aisle of the main shop. The columns in the outer wall of the power house correspond with those between it and the main shop, except that the truss connection plates are not symmetrical, projecting from the inner flange only.



Transverse Roof Truss Supported on Lattice Girder.



Longitudinal Lattice Girder.



Main Shop Roof Truss.

The longitudinal lattice girders connecting the interior columns in the main shop are 9 ft. 4 in. deep over all and 48 ft. long on centers of columns, and are symmetrical about their center line, being divided into six 8-ft. panels by vertical members. The top and bottom chords are made of pairs of 6x4x¾-in. full-length angles spaced 15⅛ in. apart back to back, so that they will clear the flanges of the supporting columns which they engage, and are field-riveted to the end gusset plates which provide connections for the diagonal members.

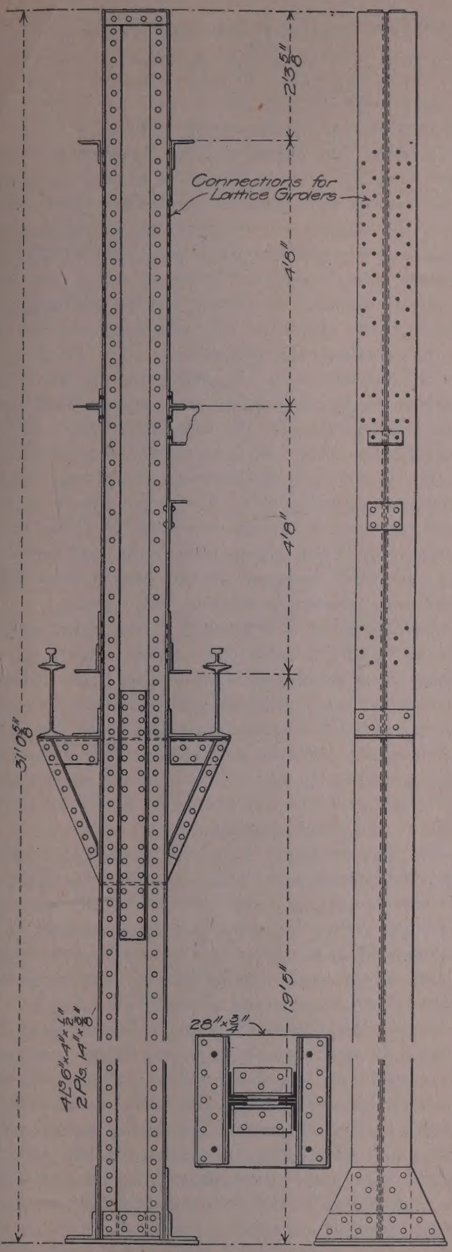
The location of the columns is such that the interior columns are midway between the transverse lines connecting the wall columns, thus bringing the transverse roof trusses in the planes of the wall columns coincident with the alternate vertical posts in the trusses. Each truss, therefore, supports three transverse trusses 16 ft. apart on centers. The top chords of the transverse trusses are 27⅝ in. higher than those of the longitudinal trusses, and are seated on them with horizontal flange angles riveted to extensions of the end connection plates of the transverse trusses. The ends of adjacent transverse trusses abut on the center line of the longitudinal girder and are web-spliced by pairs of field-riveted cover plates. The bottom chords of the transverse trusses are extended by false members to intersect the vertical posts of the longitudinal girders, to which they are field-riveted to tie plates projecting beyond the flanges of the vertical members.

The lower flanges of the lattice girders are at the level of the runway girders. The feet of the vertical posts intermediate between the transverse trusses are provided with short double cantilever beams made with 15-in. horizontal channels riveted across their flanges, which have vertical web connections at the ends to give intermediate support to the runway girders between columns. The vertical posts in the planes of the transverse roof trusses have at their feet horizontal transverse plates projecting on both sides of the girders to afford lateral connections to the runway girders and stiffen them against vibrations.

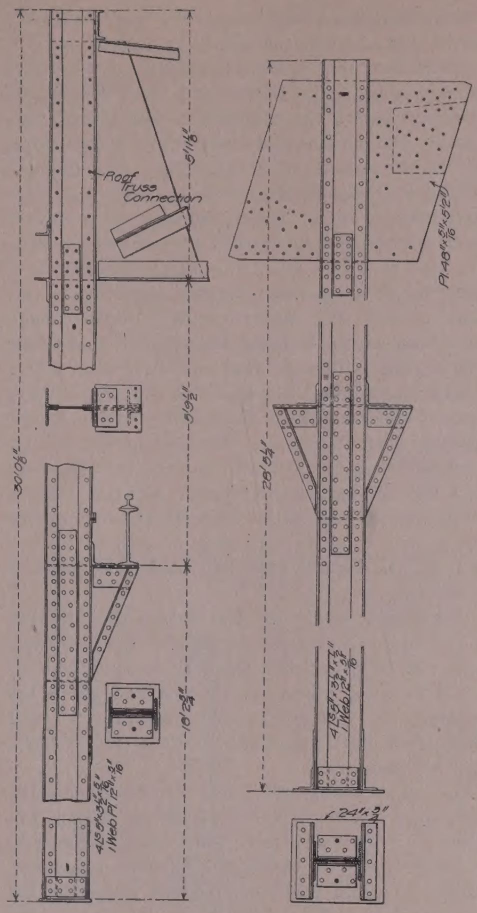
The transverse roof trusses are of simple riveted construction made of pairs of angles from 3x2½-in. to 5x3½-in., and their vertical members have field-riveted connections to the longitudinal purlin I-beams. The side aisle trusses are connected like the center aisle trusses to the longitudinal girders, and at the opposite ends have full-depth web plates field-riveted as previously described between the flange angles of the wall columns, thus providing the equivalent of a very deep kneebrace for the roof at this point. These trusses are peculiar for the irregularity of the top chords, which are bent at the first panel from the wall to provide for drainage slopes in the flat roof.

The casting room trusses, 51 ft. long from center to center of columns, are of simple construction, with stiff bottom chords having a pair of 10-in., 15-lb. channels riveted together back to back, with connection plates between the webs. The ends of the trusses have web connection plates riveted between the flange angles of the end columns, and the lower chords are continued to the columns, with which they are connected by pairs of field-riveted angle clips. These trusses carry monitor frames 5½ ft. high and about 18 ft. wide.

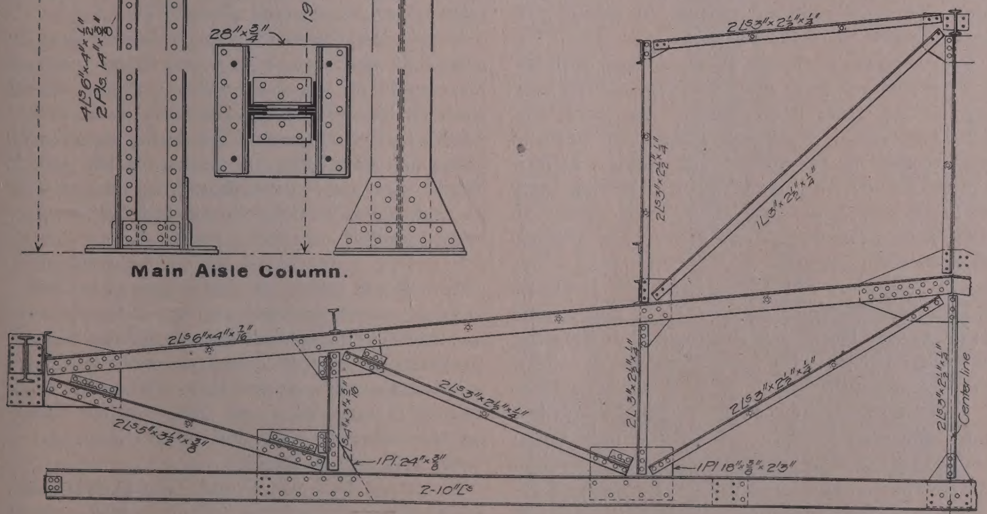
The saw-tooth roof frames are simple triangular trusses made of pairs of angles riveted together and having top chords consisting of pairs of 6-in., 8-lb. channels serving as rafters to support concrete roof slabs, which cover them and the 16-ft.



Main Aisle Column.



Power House Column.



Semi-Roof Truss and Monitor Frame.

panels between the saw-tooth frames as well as the outer edges of the roof over the side aisles and the power house and casting room roofs and monitor roofs. The longitudinal beams or purlins carrying the heavy concrete slabs are indicated on the part plan of the roof and are shown in cross-section in the elevation of the trusses over the center aisles.

The casting room is not equipped with cranes, but has instead a system of trolley hoists running on 12-in. I-beams which form two full-length lines of tracks parallel with the roof trusses and transverse to the aisles of the main shop. These lines have curved connections providing continuous circuit loops and switches. They are made with 12-in. I-beams web-connected at joints and suspended from the roof trusses and special girders provided to support them where necessary.

The building was designed and erected by the American Bridge Co.

Inadequate Foundations for the columns of a tower of a cotton mill at Crawford, Ga., nearly caused a serious accident to that structure. The tank held 150,000 gal. and was supported on a 70-ft. steel tower. The four pedestals carrying the tower were built of ashlar masonry on the outside and three of them were filled inside with rubble laid in cement. The upper part of one of the pedestals had a filling of broken brickbats and mortar. Each pedestal was capped with a 12-in. granite block in one piece. When the tank was filled and the whole load supplied, the cap supported by the pedestal containing the brick filling cracked and allowed the column to settle about 2 in. The water was drawn out in time to save a complete collapse. The affected column was jacked up and the stone cap replaced by one of cast iron. It is understood that no further settlement has occurred since these repairs were made.

Signals in the Electric Zone of the New York Central R. R.

The signal system in the Electric Zone of the New York Central & Hudson River R. R., covering its New York suburban district, is one of the largest ever undertaken in a single contract. Both block and interlocking work will be all-electric, operated by alternating current from a power line running the whole length of the system. The only batteries will be storage batteries for interlocking apparatus and will be charged by motor-generators operated from the power line. About 54 miles of four-track line will be equipped and the installation will require about 3,000 interlocking levers and 1,400 track circuits having a length of about 250 miles. The Young system of the General Railway Signal Co. will be used, and the work to be done at first will cover only the portions of the Zone now electrified. A description of the system was recently given at a meeting of the Engineering Section of the Franklin Institute by Mr. J. C. Irwin, superintendent of construction in the Electric Zone, and from his paper the following notes have been taken.

Power for operating the system will be taken from the two main power stations of the company at Port Morris and Yonkers, which deliver three-phase alternating current of 25 cycles and 11,000 volts, and from the various sub-stations which deliver direct current at 666 volts to the third rail for operating purposes. These sub-stations are also equipped with the transformers for the signal service, delivering alternating current at 3,000 volts to the signal transmission line, which although extending the entire length of the district to be signaled, is cut half way between each pair of sub-stations, thus making that portion of the line fed by each sub-station entirely independent of the adjoining one.

The apparatus in each sub-station is properly protected with automatic and hand-operated switches, and to insure operation, should the alternating current fail, motor-generators taking current from the storage battery system installed in each sub-station for use of traffic, will continue to feed the signal transmission line with alternating current, and the signal system will continue to work under all conditions under which traffic will be operated. A synchronizer is installed between the transformer and the motor-generator set.

The 3,000-volt transmission line consists of No. 0 bare copper wire, carried on the pole line and in the conduits used for the main transmission system, and the signal bridges are equipped with extension brackets, with cross arms, for convenience in running wire lines to signals.

For the operation of signal circuits, signal motors, indicators, and signal lighting, the 3,000-volt current is stepped down 50 volts, through transformers placed on signal bridges or transmission line poles. The secondary of the transformer is provided with a ground connection, formed by burying a 2x3-ft. x 1/16-in. copper plate, to which is brazed a No. 4 B. & S. gauge copper wire.

For track circuit operation the voltage depends on the length of track circuits, and varies from 1½ volts for circuits of 200 ft. to 8 volts for circuits of 5,000 ft. The reduction from 50 volts to the track voltage is made by a transformer provided with four taps, which will permit of one type of transformer being used on all track circuits.

In laying out the block signaling plan, the length of the block was determined by the braking distance. For speeds not exceeding 45 miles per hour the blocks were made 1,200 ft. long; for speeds between 45 and 60 miles per hour, 2,500 ft., and for speeds over 60 miles per hour, 3,000 ft., the average length of the long blocks being about 3,200 ft. All blocks have a full-block overlap. A distant signal is provided for each home signal. On account of the density of traffic and the necessity for quick operation the clearing time of signals is limited to three seconds.

The track circuits are of three types. Where they are 500 ft. or less in length, and where the drop in potential in the length of the track circuits is not greater than 50 volts, the one-rail system is used, and one rail of the track is given up for signaling purposes. There being no direct current on the signal rail it is not necessary to use any reactance bonds.

On all track circuits over 500 ft. in length, the two-rail system is used, and both track rails are employed for the return of the direct power current. On all of these circuits it is necessary to use reactance bonds, by which the connection is made around the insulated rail joints, permitting the direct current used in operating to pass, while impeding the alternating current used for track circuit work. The insulated rail joints are of the Weber pattern, with a steel angle plate on the inside. Each of the traffic rails of a track forms separate and independent conductors, so that if one rail is interrupted, the other would act as a return conductor, even if there were no cross-bonding to adjacent tracks.

The use of two styles of bonding was determined by the cross-bonding for the electric traction system. The Engineering Department of the railroad determined that the distance between such cross-bonds should not exceed 1,600 ft. For blocks that are 1,600 ft. or less in length the type of bond allowing cross-bonding at the ends of the track sections was best suited to the conditions. For track circuits over 1,600 ft. in length, where a cross-bond between one rail of each track was required every 1,600 ft., the ironless reactance bond is the least expensive and the one to be used.

All of the reactance bonds are enclosed in water-tight cast-iron boxes, set on foundations, and the boxes are filled with oil to carry off the heat generated. The bond is designed to permit the continuous passage of 3,000 amperes for each rail of the track without injurious heating. The casing of the box is made to cover the terminals and connections to the rail to keep them from being tampered with.

The track relay is of the induction motor type with two field coils. One coil is energized by the 50-volt signal operating current which gives the greater part of the energy required to magnetize the fields and armature. The other coil is energized by the current from the track rails, and this current need only be strong enough to give sufficient magnetism to rotate the armature. The armature revolves through an angle of 37½ deg., during which movement the contacts are separated through 23½ deg., and made up through 14 deg., thus giving a good rubbing contact. Especially hard carbon is used for the fixed point of the contact, while the moving point is of platinum. As the controlled current is an alternating one, there is little sparking, although currents of 2 to 3 amperes are used.

The box containing the track relay and transformer and the grid resistance has a plug in which an electric light can be cut in for use in night inspection.

The signals are to be of the General Railway Signal Co.'s motor-operated type, with mechanism placed in the base of the signal mast, and worked by a single-phase alternating motor of ¼ h.-p., using current at 50 volts. The slot mechanism is exceedingly simple, and under alternating current operation is very quick in releasing.

The signals are of the 60-deg. two-position type, using New York Central standard spectacles and blades, which impose on the signal motor a load equal to the lifting of a 17-lb. weight at a distance of 4 ft. from the center of the shaft. With this load the motor will clear the signal in from two to three seconds. The New York Central standard signal blades have square ends for home signals at interlockings, and pointed end blades on automatic home-block signals. The signal lamps are of 4 c.-p., working on a 50-volt circuit, and are connected in parallel with a fuse cut out, to allow any lamp to be disconnected, without affecting other lamps supplied on the same circuit. The filament of the lamp is wound in a small circle, to bring the point of maximum illumination within the focus of the lens.

The signals to be used in the Park Ave. tunnel will consist of lights only, without any moving parts whatever. Electric lights will be arranged in a box behind lenses of proper color, and the current for the lamps will be directly controlled by the relay contact. Lamps giving the proper color for the stop or caution indication will be lighted when the track relay contact is closed.

With this installation the colors used by the New York Central for the night signal indication will be changed in the electric zone, and instead of using white for proceed and green for caution, the system of using green for proceed and yellow for caution will be used for the first time on this line.

The interlockings are of the standard type manufactured by the General Railway Signal Co. Direct current furnished from storage batteries is used to operate the switch movement and signals. As usual with this type of apparatus the indication is given by the current formed by the motor, which on completing its stroke at the signal or switch movement, is changed to a generator and gives sufficient current to release the lock of the lever of the machine.

The current to change these storage batteries will be obtained from a motor-generator set, taking current from a transformer fed from the 3,000-volt signal transmission line and furnishing current of 150 volts. The storage battery consists of fifty-five cells of capacity varying from 80 to 320 amp.-hours, according to the number of daily lever movements to be made. The average time between charging will be four days. The motor-generators with switchboards will be placed in the basement of tower buildings and a separate battery-house will be provided to keep the fumes of the batteries away from the signalmen and the apparatus in the towers.

The interlocking machines are provided with a latch for each lever to require a definite action on the part of the operator to change the position of the lever. The lever handles are colored according to their functions. There will be a separate lever for each high signal arm and no selectors will be used.

The interlocking signals will be of the General Railway Signal Co. type with dynamic indication current return. These signals, where slotted, will turn to the stop position when the current through the slot magnet is open, but the return indication from the signal motor is not received at the lever until the lever is restored to the normal position. The operating circuits for the signals are run through controllers on all facing switches in the main line, insuring that the switches are properly set before the signals can be cleared.

Block signals on the same mast with distant signals are controlled by a lever in the machine requiring the block signal to be changed to the stop position before a signal can be cleared for a reverse movement on the main line.

The advance signals for each track, although operating as automatic block signals, are controlled from the interlocking and are provided with a square end blade to enable the signal man to hold a train, if it is desired to do so.

Approach locking will be provided for all main-line switches. This locking becomes effective when a train has reached a point at least one mile in the rear of the distant signal.

To permit the signal man to change the route for a train, in case of a mistake in setting it up, a mechanical screw release is provided. This will allow the release of the lever and changing the route on the expiration of a time interval of 1½ minutes after the signals have been returned to the stop position. A counter reading to five figures is to be placed on all high signals to register the number of movements.

The movement to be used to operate the switches is of an entirely new type. With the small clearance under the third-rail contact shoe, a mechanism that will not project above the top of the running rail is absolutely necessary. This movement is enclosed in a casing with the gear and escapement crank horizontally arranged. The reversible pole changer and indication switch-box are also enclosed in the casing with the switch mechanism, protecting these parts.

The movement is fitted with an improved locking device which, in the case of the plunger catching on the locking rods, as it will do if the switch does not lock up properly, will release the plunger, allowing it to stop while the main part of the movement completes its stroke. The arrangement prevents the motor from forcing the plunger through the lock rod in case it should not have come to the proper position.

The type of dwarf signal to be used is a new one, the signal arm being moved by a motor mechanism arranged horizontally at the base of the post. With this apparatus the indication will be returned to the lever by the current generated by the motor instead of by battery current, as is required with a solenoid mechanism.

In this installation the use of detector bars is practically abolished, a few only being used on the outside rail on sharp curves. Short electric track circuits are provided in their place, effecting the locking of the switches during train movements by controlling the locks on the switch levers. The use of these short-track circuits with the controlling wires to the interlocking machine, makes possible at small expense the use in the interlocking tower of an illuminated track indicator. It will consist of a track plan of the interlocking painted on a piece of ground glass with the track circuit sections divided on the back of the glass into separate compartments in which are a red and a white electric light. When the track section is occupied a red light will be shown on the indicator plan, and when unoccupied a white light will be shown.

In places like the Grand Central Terminal, where the tracks will be entirely roofed over, it will not be possible for the signal man to observe the movements of many of the trains; and an indicator of this kind is an absolute necessity to enable him to keep in touch with the situation. As in the Park Ave. tunnel, the signals in the Grand Central Station interlocking will be shown entirely by lights without any blades or moving parts. In this interlocking work, however, the lever for the signal completes the circuit for the lamps to give the proper color for the indication required.

The Reclamation of Semi-Arid Districts in Australia has been practiced for some time. In New South Wales alone over 2,000,000 acres have been watered by works constructed by the colony in districts formerly periodically denuded of stock by frequent droughts. These works have been very successful and are productive of direct revenue. The same is true of Queensland, where the development of ground water has been conducted on an enormous scale by the colony and proved of great help to grazers.

Concrete Pile Foundations for a Tower 700 Feet High.

The Friede Globe Tower at Coney Island, New York, is to be a steel structure 700 ft. in height, intended entirely for amusement purposes. The circular steel framework, about 290 ft. in diameter at the base, will weigh about 8,000 tons and will have 49 columns in the lower section. These are seated on 41 rectangular concrete piers with concrete pile footings, 40 of them being arranged in three rings concentric with the center pier. The inner eight are spaced equidistantly on a circle 61 ft. in diameter, 16 more are spaced at alternate intervals of 11 deg. 15 min. and 33 deg. 45 min. on a circle 231 ft. in diameter, while the remaining 16 are spaced at the same angular intervals and on the same radial lines on the outer circles 290 ft. in diameter. The center pier has 16 piles, each pier in the two inner circles has 25 piles, each pier in the outer circle has 9 piles. Besides the piles in these piers there are 55 more arranged in two circles between the first and second circle, making a total of 815 piles.

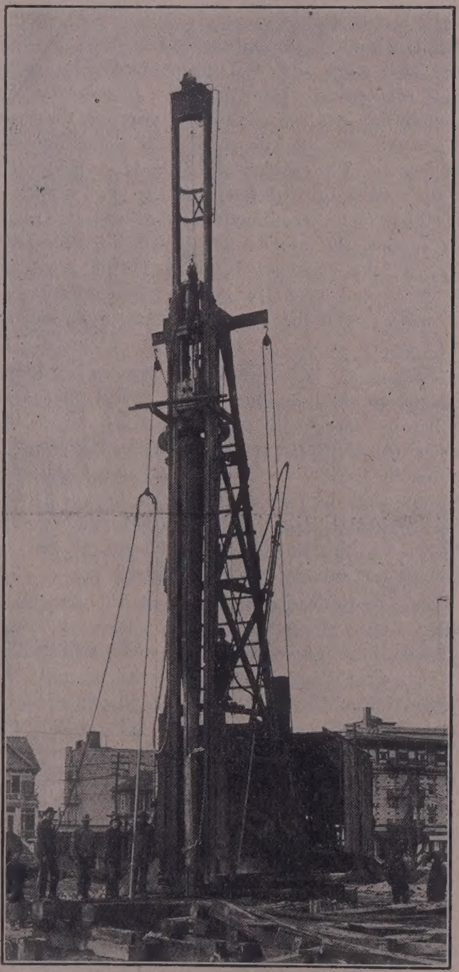
The surface of the sand is leveled off 1 ft. below the tops of the piles, and the latter are enclosed by rectangular concrete piers 2 ft. 3 in. deep for the nine-pile piers and 2 ft. 7 in. for the 25-pile piers. The pier concrete engages the upper ends of bent rods projecting beyond the tops of the piles and is thus anchored to the latter so as to resist many tons of upward reaction. This is, however, unnecessary as the tower will have a positive moment of stability under the heaviest assumed wind pressure. Short vertical rods with their upper ends bent at right angles, making them appear like masonry dogs, are bedded in the pier concrete and project above its upper surface between the webs of the grillage I-beams so that when the latter are set and the interstices between them are filled with concrete, the bent rods will form an additional bond between the upper and lower layers of concrete and will practically extend the anchorage from the piles to the column bases. The foundation construction is now practically completed and as contracts have been awarded for a portion of the steel work, it is expected that its erection will be vigorously advanced during the present season.

The tower is located about 800 ft. from the high-tide mark on the beach, where the soil consists entirely of fine wet sand, in which the foundation piles are driven to a depth of about 30 ft. They are of the Raymond concrete type and are made in the standard manner by first driving with a solid steel core a thin conical steel shell, which excludes sand and water and is filled with concrete after the core is withdrawn. The piles are about 8 in. in diameter at the point and 20 in. at the top, and are calculated to have a bearing capacity of 75 tons each, but are loaded with only 37 tons each.

Although the foundation work was commenced last season it was so much delayed by the removal of obstructions to the site that it is only now being completed. Part of the area occupied by the tower was formerly used as a swimming pool with concrete walls and bottom, which had to be cleared away, while other portions were covered by large and small buildings and by a steel tower about 100 ft. high, which supported at the top a pair of tilting trusses 150 ft. long, with two circular frames 35 ft. in diameter at the extremities, forming a giant see-saw, which weighed in all about 300 tons, and had to be moved transversely about 400 ft. before the foundations could be completed.

The cores are driven by a pile driver with steel leads about 55 ft. high and an I-beam base 25 ft. long seated on a turn-table 10 ft. in diameter, with its base provided with rollers, thus enabling the machine to be moved back or forward on timber sills and to be revolved 360 deg. so as to command all of the piles in each foundation group without moving the base of the machine. The leads are balanced by a two-drum, two-spool Lidgerwood hoisting engine at the opposite end of the platform, which handles the core with one of its steel drum lines. As the sand is so dense that impact driving is impracticable, holes are first made with a hydraulic jet and the piles are placed in them and driven to the required depth.

A 1½-in. pipe about 35 ft. long is fitted with a ¾-in. nozzle at the lower end and at the upper end has a steel goose neck connected by a flexible hose to a 2-in. main supplying city water under a pressure of about 70 lb. per square inch. The pipe is handled by a rope attached to the goose neck, passing over a sheave at the top of the leads and then to one of the spools of the hoisting engine. The pressure being turned on, the nozzle is rapidly churned up and down 1 or 2 ft. by the man who handles the tail rope at the spool, and the jet quickly scours out and maintains a hole 25 ft. deep. The core and shell are lowered into this from the leads and are driven to the required depth by a No. 2 Vulcan steam hammer operated by steam from the hoisting engine boiler. As the core weighs about 7,000 lb. and the steam hammer about 6,500 lb., the constant weight is a great advantage in settling the pile and it is driven to a very solid bearing, usually with little difficulty, although the driving varied greatly and sometimes required as many as 700 blows after the removal of the jet.



Steel Pile Driver.

The core itself is about 8 in. in diameter at the point and 20 in. in diameter at the top and is 32 ft. long. It is made of three transversely adjustable longitudinal sections which, after the core is driven, are slightly collapsed to enable it to be readily withdrawn from the shell, which remains permanently in the ground. The shell is a frustum of a cone made of four sections of No. 20-gauge unannealed sheet iron with locked longitudinal seams and telescopic transverse joints, and is finished at the bottom with a cylindrical boot 18 in. long stamped from No. 16 gauge steel.

While the core is suspended in the leads with its points about 8 ft. clear of the ground, the upper section of the shell is lifted by a whip line running over the top of the leads to one of the spools, and is drawn over the bottom of the core and pulled as high up on it as it will go. It is maintained there by friction against the surface of the core and the next section is put in place in the same manner, as well as the third and fourth joints, after which the boot is placed over the foot of the core and the shell is completed and lowered with the core into the pit, formed as already described by the hydraulic jet.

After it is driven to the required depth, the core is collapsed and withdrawn and, when necessary, a steam syphon is lowered to the bottom of the shell to clear it of water, which takes about 2 minutes. In some cases quicksand has been encountered so fine and troublesome that it was necessary to cover the joints of the shell with an outside sheet to exclude it, and in the worst cases it was also necessary to pack the sleeves with tarred felt. These precautions sufficed to make the shells tight enough so that they could be maintained free from water until filled with concrete. Five ¾-in. bent rods, 26 ft. long, tied together in four places with No. 11 wire, were placed equi-distantly with their hook ends projecting above the top of each of the shells. Sand, gravel and cement were delivered by wheelbarrows to a small cantilever platform on the forward end of the pile driver machine and were there hand mixed rather dry, to make 1:3:5 concrete, using Atlas Portland cement and ¾-in. gravel. This was immediately shoveled by hand into the open shell adjacent, nearly 1 cu. yd. being required for each pile. As soon as the pile shell was filled, the core was redriven adjacent to it for the next pile and so on, from 8 to 16 piles being thus driven in each 8-hr. day, according to the number in each foundation cluster and the difficulties encountered by obstructions. Some trouble and delay were occasioned by the treacherous character of the sand, which often washed away during the jetting process so badly as to undermine the pile driver foundations and in some instances nearly upset it.

In some previous jobs the contractor has manufactured the pile shells at his yard and shipped them complete to the job, but in this case there were enough of them to make it advantageous to ship the flat sheets of steel 8 ft. long to the site and there manufacture the shells. The sheets are laid on a table and rapidly cut by hand shears to the required shape corresponding with the development of the frustum of the cone, and are then taken to a hand machine operated by two men who bend up a strip about ¾ in. wide at right angles on one longitudinal edge and make a return bend of about the same width and 180 deg. on the other edge. They then slip the sheet transversely through the machine, making numerous small oblique bends, slightly divergent to correspond with the elements of the cone, and thus change the plate from a flat to an approximately conical surface. Two of the duplicate plates are then taken and their male and female joints engaged, thus uniting them to form the conical frustum. This is placed on a heavy horizontal cantilever rail about 2½ ft. above the ground which serves as a mandrel on which the partly made joints are hammered flat against the surface of the cone and thus completed. The sections are made at the rate of 50 in 8 hours by a force of three men.

The work has been carried on with the superintendent and an average force of about twenty men, seven to operate the pile driver, eight for the concreting, three making shells and two helpers.

Mr. Samuel M. Friede is the architect of the tower. Mr. F. A. Burdette is the consulting engineer who designed the entire structural work and foundations. The foundation contract has been executed by the Raymond Concrete Pile Co., Chicago and New York, Mr. H. R. Moyer, treasurer, and Mr. G. B. Raymond, superintendent in charge.

Book Notes.

Mr. George P. Carver, lately division engineer on the Florida East Coast Ry., where a large amount of concrete arch work is being done, has prepared a small pamphlet entitled "Instructions to Inspectors on Reinforced Concrete Construction," which will be useful to those engineers who do not care to prepare such instructions for their own forces. It covers both building and bridge construction and gives a number of tables of assistance to concrete workers. (Beverly, Mass., Payson Publishing Co., 50 cents.)

The attention now being given to water softening by many American railway companies makes the appearance of a translation of Messrs. Edmund and Fritz Wehrenfennig's "Analysis and Softening of Boiler Feed Water" decidedly timely. Mr. Edmund Wehrenfennig is the chief inspector of the Austrian Northwestern Ry.; he has made water softening a special subject of study for nearly twenty years, and has taken out a number of patents for apparatus used for the purpose. Softening plants have been extensively used in Austria, and the book contains a large amount of information regarding them, and Mr. Fritz Wehrenfennig, an industrial chemist, has furnished data regarding the chemical features in the operations of such plants. The purpose of the authors has apparently been to furnish engineers who are not chemists with information to enable them to control the operation of softening apparatus even where the water to be treated varies in character. While The Engineering Record is firmly convinced that money will be saved in the long run by calling upon chemical specialists for such work, the book will undoubtedly prove useful to many readers. It gives directions for making analyses of raw water and calculating the charges of chemicals necessary for water softening. This work can be done in an hour, the authors state, while the preparation of the reagents and the treatment of a test sample takes three to six hours. The introductory chapter is on the impurities in water. The second chapter explains the methods of analysis, and the following chapter describes the preparation of the chemicals used in such work. The fourth chapter describes different methods of purifying water and contains a large table showing the treatment considered best by the authors for water containing different hardening substances. Chapter five explains methods for determining the amounts of reagents for softening purposes, and the next two chapters are on tests to determine the extent of the softening and on the removals of the precipitates from the treated water. Chapter eight is a general explanation of the process of softening and the apparatus used for the purpose. Chapter nine is an account of the development of water softening methods and the next chapter contains comments on them. The eleventh chapter is the longest and most important in the book and describes numerous plants for different operating conditions. The book closes with an abstract of a report on water softening by a committee of the Society of German Railway managers. The translation of the book is by Mr. D. W. Patterson, of Philadelphia. (New York, John Wiley & Sons, $4.)

Letters to the Editor.

PROPOSED FLOOD PREVENTION LEGISLATION IN PENNSYLVANIA.

SIR: I enclose a copy of a bill recently presented in the House of Representatives of Pennsylvania, and a few words in explanation thereof, in the hopes of bringing the subject to the attention of the engineers of this State who are interested in the subject.

"Section 1. Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in General Assembly met and it is hereby enacted by the authority of the same, That the Water Supply Commission of Pennsylvania be and is hereby directed to proceed to investigate plans and methods for the controlling of flood waters in the Allegheny, Monongahela, Ohio and Susquehanna rivers and other streams in which the Commission may deem necessary and to report what in its opinion after such an investigation is the most feasible and best plan for this purpose which report shall set out in detail the plan adopted by the Commission with a detailed report of the cost of constructing the said works and of maintaining the same. The said report shall be presented to the Legislature of 1909 and the said Commission shall also recommend in said report a plan for raising the money which will be necessary to meet the expenses incurred in the purchase of lands and property and in the construction or works and the operation and maintenance of same.

"Section 2. The sum of $20,000 or so much thereof as may be necessary be and the same is hereby specifically appropriated to cover the cost and expenses entailed by the provisions contained in section one of this act. That the said amount shall be paid on vouchers duly presented and certified to the Auditor General by warrant drawn by him on the State Treasurer out of moneys not otherwise appropriated."

The recent destructive flood at Pittsburg and other points along the western rivers of Pennsylvania has had its effect upon the Legislature of that State, and it is hoped that through the destruction and loss of property it wrought, legislation may be enacted which will enable the first steps to be taken toward relieving the flood conditions in Pennsylvania. This State has for a generation been notorious for its floods, beginning with the historical catastrophe at Johnstown in 1889, and ending with the Pittsburg flood of March 14 and 15, 1907. The flood of 1904, it is reported, destroyed between $6,000,000 and $7,000,000 worth of property along the Susquehanna River, including $800,000 damage to state bridges. With these object lessons and the constant warnings that, with the increasing density of population and the development of industry, the floods are sure to become more frequent and destructive, it is probable that the Legislature will take favorable action upon the bill now pending.

The Water Supply Commission recognized, immediately after its organization in 1905, that this question was going to present itself sooner or later, and has been collecting and studying the available data bearing on this subject. The people of the State have taken the matter up eagerly, particularly those in the valley of the oft-flooded Susquehanna River. Citizens' committees have been appointed to express the approval of many of the cities bordering the river to the bill, and the newspapers and Chamber of Commerce of Pittsburg have become actively interested.

The time is evidently ripe for beginning the study of this great question in Pennsylvania. Any work of this character cannot be undertaken without careful investigation and study, and if the experience of other States can be a guide, many investigations and many reports will be made before the actual work is commenced. A start has to be made some time and now, while the subject is receiving wide newspaper and magazine prominence, seems a fitting time.

Yours truly, FARLEY GANNETT.
Harrisburg, April 19.

SEEPAGE LOSSES FROM CANALS.

SIR: The irrigation department of the Experiment Station of the University of California is investigating canal linings to stop seepage losses. This work was begun last year and is to be continued this summer. What is wanted is to find the cheapest material and simplest process; something which can be used on laterals as well as large canals, something which will check if not stop the percolation of water, prevent the growth of vegetation in canals, and obstruct burrowing animals. Cement is effective but costly. Clay for puddling is not to be had in many valleys where water is valuable. There are, however, an unusual number of raw materials in this State which promise well, crude oil and asphaltum being the most abundant, and the special purpose of this year's investigation is to test the native materials.

The results of last year's tests will soon be published as a station bulletin. They showed cement concrete to be most effective, but it cost six times as much as a lining of crude oil, which cut down the loss more than half, stopped all vegetable growth, and ended the work of gophers.

We wish the interest and co-operation of the canal managers and irrigators everywhere. We are especially desirous of securing two things:

1. From every irrigator or canal manager who has a lined ditch or reservoir a description of how the work was done, what it cost and what the result has been.

2. Suggestions as to the experiments it is desirable to have us make, especially of material or methods of applying linings.

We are desirous of obtaining suggestions on this matter from all sections of the country, and I shall be very glad if you will publish this letter.

Sincerely yours, ELWOOD MEAD.
Berkeley, Cal., April 10.

DROP MANHOLE PATENTS.

SIR: The following may be of general interest to the engineering profession: During the year 1906 the city of Centerville, Ia., was made the defendant in a suit to recover royalties of $10 apiece on all drop manholes used by the city in the construction of its sanitary sewer system, by one Alexander Donahey, of Kirksville, Mo., who is the assignee of the James P. Bates patent on drop manholes obtained in 1892. Suit was brought in the United States Federal Court at Keokuk, Ia., and was heard April 16, 1907, at that city. The decision of the court was that the Bates patent is lacking in novelty, discovery, etc., to the extent that it was not patentable, and directed a verdict for the city of Centerville. The plaintiff, however, took a non-suit. The decision of the court was made after the plaintiff had rested his case and before the defense had produced its evidence of priority of use and other defenses, which we believed to be sufficient to have won our case anyhow. The Bates patent was for 17 years and hence will be out after two years more. This seems to have been the first time that its owner had nerve enough to go into court to collect royalties.

Yours truly, M. G. HALL.
Centerville, Ia., April 18.